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CATCH CROPS IN PERMANENT CULTIVATIONS.

The capital cost of bringing many tropical products into bearing is heavy. Besides the initial cost of opening the land, there is a long wait, during which the cost of upkeep is not inconsiderable, before crops begin to come into bearing.

To reduce this initial capital outlay has been the aim of practical agriculturists throughout the tropics, and the growth of catch crops during the first few years of the permanent cultivation has in many parts become general.

In the West Indies, for example, cacao is always brought into bearing with food products such as plantains, tannia yams, manioc, etc. These products grow rapidly and afford the light shade so necessary for the young cacao plants and yield an early monetary return which helps to offset the heavy costs of opening the land.

In Java, young rubber is interplanted with Robusta coffee and in the Federated Malay States the same product is at times used as an intercrop with rubber. This coffee yields early crops, is benefited by the light shade of the rubber and is eventually cut out when the rubber comes into bearing.

In Ceylon, the growth of catch crops in permanent cultivations is carried on by some agriculturists, but is not at all general.

Land cleared for coconuts is sometimes planted with such products as plantains, sweet potatos, pumpkins, brinjals and chillies, and an example of coconuts interplanted with catch crops of pumpkins, chillies and plantains has recently been inspected by agricultural officers. These catch crops have

yielded satisfactory profits. In fact, they have paid the costs of opening and of upkeep for the first two years, while the growth of the young coconuts has in no way been interfered with.

The covering of the land between permanent crops with some soil-covering crop during the first few years has much to commend it from a scientific point of view and it helps to keep down the growth of weeds. The harvesting of root crops may help in the matter of cultivation.

During the efforts of the past few months towards the encouragement of a greater production of food stuffs, vegetables and curry stuffs there have been numerous requests for advice as to the desirability or otherwise of growing catch crops between young plantations of rubber, coconuts and tea.

It has been pointed out that growing such catch crops can be recommended without hesitation on lands planted with rubber and coconuts, and in certain cases where tea is being cultivated. For the former crops, the following food crops suggest themselves as being suitable: plantains, tannia yams, yams, sweet potatos, pumpkins, dhall, beans, cow-peas, brinjals, tomatos and chillies, while in the case of tea it is thought that the crops should be limited to leguminous plants such as dhall and beans or to low growing plants such as brinjals and chillies.

The choice of crops must depend upon the situation of the plantation in regard to markets and means of communication. If tannia yams, yams or sweet potatos are decided upon, their growth should be limited to the first two years of the plantation, as their harvesting necessitates a considerable turning up of the soil and some damage to the roots of the permanent crops if they are more than two to three years old. Forking or cultivation in permanent crops generally gives satisfactory results when carried out at the correct season, but the harvesting of root crops often becomes necessary when on account of prevailing climatic conditions little disturbance of the soil should be done in permanent plantations that have root systems well developed.

In planting catch crops, it is of the greatest importance that they should not be planted too thickly nor too close to the plants which are to form the permanent cultivation. The rubber, coconut and tea crops should always be looked upon as the main crops and the sacrifice of some of the catch crops must never be grudged when the interests of the permanent crops demand it.

FOOD STUFFS.

HINTS TO ONION-GROWERS.

It is important for the onion-grower to bear in mind that the growing of onions for seed purposes must not be combined together with that of raising bulbs for the market or for his own consumption.

Onion seedlings raised from seed and transplanted out into the field generally flower in about four months. These flowers should be removed. A month later the leaves begin to turn yellow and wither. The crop is then ready for harvest.

Flowering is suppressed for two reasons:—1st. For flowering and seeding, plants are known to utilise their food-reserves in large quantities. The bulbs in which food-material is stored will not be plump and well-filled if flowering was allowed to take place.

2nd. It is the experience in India, at any rate, that onion plants though flowering do not give good seed in the first season of growth.

In growing onions for seed, the practice adopted in Bombay is to give the bulbs from a harvested crop some months' rest. Prior to planting out, the top part to the extent of a quarter of the bulb is cut off and the lower part is planted out in well-prepared beds about 6 in. apart. From these, flowering shoots very soon appear and ripen to seed in February-March if the "sets" were planted out in October-November. The seeds thus obtained can be stored and used for the next September-October sowing.

In Bombay the cold weather crop grown under irrigation gives the highest yields. An yield of 20,000 lb. is not uncommon. Wherever onion is grown as a rain-fed crop the yield is low. Under such conditions transplanting is not practised. Drills are opened out both lengthwise and crosswise by a four-coultered drill having its coulters one foot apart. The seed is planted where the lines meet. In Antigua (W. Indies) the method of sowing the seeds in drills in the open is adopted because of the weather conditions. The onions are found to mature almost a month earlier. The yields vary from 5,000 to 8,000 lb. In Ceylon, except in our dry irrigable tracts, the heavy monsoon rains will be found to limit the growing season so that any system whereby the bulbs mature early is to be preferred. Transplanting, for this reason, may not be found practicable.

In rainy districts another disadvantage noted is that the bulbs rarely become large and that they tend to divide up into smaller bulbs. When the crop is harvested, the smaller bulbs should be separated out and planted in the next season. For example, in the wet low country, April-May is considered the best time for sowing onions and the crop is harvested before the heavy rains in September-October. The smaller bulbs harvested might with advantage be planted out in October-November and lifted up early in February.

Such methods are often adopted in different parts of India to secure onions for very early markets. The crop has often, in such cases, to be harvested when it is still green.

After harvesting, a very necessary precaution is to dry the bulbs before storing. This is often rendered difficult by the fact that in some parts of Ceylon, wet months follow the harvesting time. Drying out in the sun might not often be practicable. In Bombay special storage houses are constructed out of grass thatchings. The walls are made of split bamboo with spaces between.

The onions should not be heaped up but spread out evenly and thinly allowing free access of air all round the bulbs. When the outer skin dries to a fine papery texture, brittle to the touch, the onions can be stored with safety. Neglect of this precaution may cause the development of a wet rot throughout the whole heap.

H. L. VAN B.

INSECT PESTS OF FOOD CROPS.

CATERPILLARS AND BEETLES WHICH EAT LEAVES.

Various kinds of caterpillars eat the leaves of almost all vegetables and crops and sometimes do considerable damage. If only a small patch of land is affected, or if the caterpillars are not very numerous, the best plan will be to collect them by hand and put them into tins containing water and a little kerosene. This will kill them. Any butterflies or moths which lurk about the cultivated crops should be caught and destroyed to prevent them from laying eggs from which fresh caterpillars will hatch.

Beetles of various kinds feed on the leaves of Cabbages, Cauliflowers, Bandakka, Pumpkins, Snake-gourds, Cucumbers and many other vegetables. Some of these beetles have the habit of dropping to the ground, when the plant they are on is disturbed in any way. For such beetles as these a cloth or newspaper should be spread underneath the plants and the latter should then be tapped or shaken to cause the beetles to fall on to the white surface below when they can be collected and destroyed. Other kinds of beetles fly readily and these should be caught with butterfly nets and destroyed.

ROOT EATING GRUBS.

There are many different kinds of grubs which live below the soil and eat the roots of various grains, carrots, potatos, beans and peas, English vegetables and curry-stuffs etc. Some of these grubs are white, while others are black in colour. To prevent attacks by these pests, all ground should be thoroughly well dug up, weeded and turned over before seeds are planted. Any grubs seen should be killed. If plants are already growing when grubs commence to destroy them, very often the most satisfactory way is to dig the grubs up from the roots of each attacked plant.

At high elevations, vegetable growers are often much troubled by fat, black caterpillars which live underground during the day and come up at night to bite off tender seedlings and take them underground to eat. The usual way to circumvent these pests is by enclosing the stem of each plant with a tin cylinder or by tying paper round the stems. These caterpillars may often be trapped by leaving cabbage-leaves, cut grass, etc., on the ground covered with a tile or slab of wood. The grubs collect under the masses and may be easily destroyed every morning. In other parts of the world, poisoned baits made as follows, have been found very effective :—

Mix 25 lb. Bran with ½ lb. Paris green or other arsenic salt dry, and add 1 quart of molasses or jaggery syrup which has been diluted with water. Mix thoroughly and add enough more water to make the mixture into a moist mass. This should be placed in little heaps in gardens affected with surface-caterpillars. They eat it and are poisoned by the Paris green or arsenic.

STEM-BORING GRUBS.

Stem-boring grubs are of many kinds. They are difficult to keep in check, as the plant is usually seriously damaged before anything is noticed to be wrong with it. In such cases all that can be done is to cut off, or in the case of grains, pull up the affected plant or branch and burn it, so as to ensure that the adult insect shall not emerge and commence a fresh brood of borers. In order to prevent boring insects from perpetuating themselves it is very important that all crops should be dug up and buried deeply as soon as the crop has been gathered. Plants should not be left to run wild after crop, as this directly encourages the increase and spread of such insect pests.

Boring grubs attack Brinjal stems, Kurakkan, Paddy, Dhurra, Sugar-cane, Bean-plants and many kinds of fruit trees.

FRUIT-BORING GRUBS AND MAGGOTS.

Fruit-boring grubs and maggots attack Pumpkins, Cucumbers, Melons, Snake-gourds, Bitter-gourds, Guavas, Cherimoyer, Brinjals, Mangos, etc. Here, again, preventive measures are cheapest and best. As soon as any fruit or pod is seen to be attacked it should be picked and at once buried at least 2 feet deep under well-stamped earth. This will prevent the pest from increasing, which will surely happen if the fruit is either left on the tree or allowed to lie rotting on the ground. Some fruit maggots become moths, while others become flies or beetles in the adult stage, The Pumpkin fruit maggot, which becomes a fly, does a great deal of damage to all kinds of gourds, and to prevent this, the flowers of such gourds should be enclosed in cloth or paper bags as soon as they begin to wither. This will prevent the flies from laying their eggs in the skin of the fruit. Some gourds such as Cucumbers, which trail along the ground, may be protected by covering the fruits with a little earth. The parent flies may be trapped by exposing over-ripe fruits near the orchard so that the flies lay their eggs in them. After two or three days these traps should be collected and burned or buried deeply underground.

PLANT BUGS.

Active Sucking Insects, or plant-bugs attack almost every crop. They are of many kinds varying from a very small size to a comparatively large one, and they are of all colours. In general they resemble beetles, but they do not bite their food but suck the sap by means of a long beak which they thrust into the tissues of plants. Many plant-bugs give off a very unpleasant smell when they are disturbed or injured. They attack the following crops: Bandakka, Beans, Paddy, ("Paddy-fly") Red-gram, Green-gram, Kurakkan, Cabbages and Cauliflowers and many other vegetables and curry-stuffs. In these insects there is no grub stage, the young being similar to the adults but without wings. Frequently they congregate in masses, when they may be easily collected and destroyed. Netting with butterfly nets is a good way to reduce the numbers of the flying adults, and young plant-bugs may be shaken off the plants into the nets and then thrown into tins containing water and kerosene oil, which will speedily kill them. Or, sheets of cloth saturated with coconut or kerosene oil may be spread beneath the plants, and the bugs shaken on to them.

SCALE INSECTS.

These are insects which settle down on plants and suck the sap continuously without moving about much, except in the very young stages. They are of many kinds, some being like oval, hard scales on the leaves, etc., while others are soft and covered with white powder or fluff (Mealy bugs). Many are very hard to distinguish from natural marks or features of the plant. Scale insects are almost always accompanied by a black, sooty appearance on the leaves due to a fungus which grows on the excreta of the insects. This black fungus often indicates the presence of Scale-insects when there is

no other sign of their presence. They attack practically every plant in some way—some living on the leaves, some on the stem or twigs and some even on the roots. The mealy-bugs are very commonly found on the leaves and stalks of Brinjals, Chillie, Guava, Beans, Grams, Peas, Pepper, Fruit-trees, etc. They form large masses which, by continually sucking the sap, weaken the plant they are on, and sometimes even kill it. Scale insects always seem to prefer plants which are already unhealthy so it is important to keep plants in vigorous growth by careful cultivation. When a plant is badly attacked by scale-insects, very often the most satisfactory course is to cut off all the affected branches and burn them on the spot; but if the crop is too valuable for this to be done, the affected branches should be carefully scraped or brushed with a coconut husk dipped in strong soap-suds to which a little kerosene has been added. The plant should be manured at the same time, to make it more vigorous. In the case of some plants, all affected leaves should be picked off at regular intervals and burned. This will have the effect of gradually reducing the pest, or exterminating it.

LIST OF COMMON PESTS.

Bandakka.	Red Cotton Stainer (Bug)	*Dysdercus cingulatus*
	Pod-boring caterpillars	*Earias insulana*
		,, *fabia*
	Leaf and shoot eater	*Cosmophila erosa*
Bean.	Pod sucker	*Riptortus pedestris*
	Stem-boring maggot	*Agromyza phaseoli*
Brinjal	Fruit borer	*Leucinodes orbonalis*
	Stem & shoot borer	*Euzophera perticella*
	Mealy-bug	*Dactylopius* spp.
Cabbage.	Cut-worm	*Agrotis* sp.
		Euxoa segetis
	Leaf-eater	*Crocidolomia linotalis*
		Hellula undalis
		Plutella maculipennis
		Prodenia litura
	Sucking sap	*Bagrada picta*
Cauliflower.		(Same as Cabbage)
Chillie.	Stem-borer	*Euzophera perucella*
	Mealy-bug	*Dactylopius* sp.
Cow-pea.	Leaf-eating caterpillar	*Plusia orichalcea*
	Pod sucker	*Riptortus pedestris*
Cucurbitaceæ.	Leaf-eating beetles	*Aulacophora* spp.
	Fruit-boring maggots	*Dacus cucurbitæ*
English Vegetables (generally)	Cut-worms	*Agrotis ypsilon*
		Euxoa segetis
	Root eating ant	*Dorylus orientalis*
Ginger.	Stem & root boring caterpillar	*Dichocrocis punctiferalis*
Gourds.	See *Curcurbitaceæ*	
Gram.	Leaf-eating caterpillars	*Plusia* spp.
		Herse convolvuli
	Seed-eating grubs	*Agromyza* sp.
		Maruca testulalis
	Food-sucking bugs	*Coptosoma* sp.
		Anoplocnemis phasiana
		Riptortus pedestris

Groundnut.	Root-eating ant	*Dorylus orientalis*
	Leaf eating caterpillars	*Amsacta* sp. *Chloridea obsoleta* *Plusia* sp.
Maize.	Cob-spoiling caterpillar	*Chloridea obsoleta*
	Shoot-boring caterpillar	*Cirphis unipuncta*
	Stem-boring caterpillars	*Sesamia inferens* *Chilo simplex*
	Sucking Bugs	*Leptocorisa varicornis* *Pyrilla aberrans*
Mustard.	Leaf-eating caterpillars	*Crocidolomia binotalis* *Hellula undalis* *Plutella maculipennis*
	Sucking bug	*Bagrada picta*
Paddy.	Leaf-eating Army worm	*Spodoptera mauritia*
	Stem-boring caterpillars	*Cirphis unipuncta* *Chilo simplex* *Schœnobius bipunctifer*
	Sucking-bug (Paddy-fly)	*Leptocorisa varicornis*
Pea.	Leaf-eating caterpillars	*Prodenia litura* *Plusia orichalcea*
Potato.	Cutworms	*Agrotis ypsilon* *Euxoa segetis*
	Leaf-eating caterpillars	*Plusia orichalcea*
	Stem boring caterpillars	*Euzophera perticella*
	Tuber borer	*Pthorimœa operculella*
Pumpkin.	Leaf-eating beetles	*Aulacophora* spp.
	Fruit-boring maggots	*Dacus cucurbitæ*
	Leaf-caterpillars	*Plusia* sp.
Radish.	Leaf-eating caterpillars	*Crocidolomia linotalis* *Hellula undalis* *Plutella maculipennis*
	Sucking bug	*Bagrada picta*
Red Gram.	Pod-boring	*Agromyza* sp. *Chloridea obsoleta* *Catachrysops cnejus* *Etiella zinckenella* *Maruca testulalis*
	Sucking bugs	*Cyclopelta siccifolia* *Anoplocnemis phasiana*
	Scale insect	*Ceroplastodes cajani*
Snake-Gourd.	Leaf-eating beetles	*Aulacophora* spp.
	Fruit boring maggots	*Dacus cucurbitæ*
Sweet Potato.	Leaf-eating Tortoise-beetle	*Aspidomorpha miliaris*
	Leaf-eating caterpillar	*Herse convolvuli*
	Tuber-boring grub	*Cylas fornicarius*

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FOOD-STUFFS IN MALAYA.

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This paper is written with one object and that is to endeavour to stimulate interest generally in connection with the growing of food stuffs in Malaya. There are very large areas in cultivation, here, but the part devoted to food supply is, in comparison, almost conspicuous by its absence. The European planter does not appear to have seriously considered the growing of such crops and it is evident that the Eastern races have, to some extent, ceased to practise what was, but a few years ago, their livelihood. It is surprising how few residents take an interest in the subject, even as far as a vegetable garden is concerned and food production on estates, to a minor or any extent, for one's own labour force is, I believe, unknown. The cooly is not the one to further the growing of such crops. He may have his small plot of land but further than that he cannot be expected to go. The small-holder, particularly the paddy planter, is the main support of what food materials are produced in this country and it is desirable that he should receive every encouragement. The larger planter has often opportunities of growing quite a variety of crops which would be of general benefit. Young rubber and coconut clearings, in the early stages of development are suited, in some cases, for the growing of food-yielding crops of short duration. I am fairly confident that a new clearing can support one or perhaps more annual crops, which take a matter of a few months to mature, without, to any appreciable extent, injurious results to the permanent crop. The culture and tilth required for the reception of a temporary crop, in many cases the primary tillage of the land, would I believe, compensate for the chemical constituents removed from the soil. In addition to this, the refuse material will, on application to the land, improve the mechanical condition of the soil which is of great importance, particularly in the tropics. I do not wish it to be understood that I favour the continued removal of one or a rotation of intercrops, but I do think that short lived catch-crops might with advantage be grown, for a time, on first class land which is free, or comparatively so, from timber.

Many uncultivated pieces of land in or adjoining estate areas might be profitably utilized for the growing of food-yielding plants of a more permanent nature.

The labour required for the proper culture of such crops is perhaps the most serious obstacle, for estates do not generally have a superfluous stock of coolies. Annual crops of this nature require more cultivation than is usual with rubber and coconut plantations. A good deal of supervision, particularly during the planting and harvesting seasons, is necessary.

The writer is well aware that this branch of agriculture is not attractive to planters as a class, but this is, in all probability, due to the all-absorbing interest of rubber cultivation rather than to the knowledge gained from practical experience, as to the possibilities of such crops.

I now propose to deal briefly with a number of food-producing plants which can be recommended if immediate production of food-stuffs is required.

MAIZE.

This cereal is of great value as an article of human food. The ripe grain is used for the production of flour and meal. The green cobs form an excellent vegetable. In rubber or coconut clearings, not exceeding two years old, I see no special objection to the cultivation of this cereal. Hickory King and a red grained Malay variety have given fairly good results here, but I do not think it can be expected that our yields will equal that of India or Ceylon. Maize requires moderately rich soils and may be grown two or three successive seasons on the same plot. In this country it probably does best in land recently brought under cultivation which has a good proportion of humus in the soil and is friable in nature. Poor soils, stiff clays and sour lands are undesirable. A thorough preparation of the land is considered essential for the production of large maize crops but with virgin land, as it would be mostly grown on here, this is not so necessary, at least for the first few crops. The land may be changkolled or forked to a depth of a few inches and the seed sown broadcast, after rain, on a well prepared surface, at the rate of 10 to 15 lb per acre, as a sole crop, and lightly turned under; a fine surface tilth is of primary importance. The seed may also be dibbled in at distances of 6 inches in rows which are 3 feet apart and thinned out, when the plants are well established, to 12 inches in the row. Surface weeding is continued and care taken not to disturb or break off any of the roots. Weeding might be done, during the time the crop is on the land, slightly deeper than is usual, in order to retard soil evaporation. The crop takes three to six months to mature depending on the variety and the conditions under which it is grown. If the cobs are required as a vegetable they are pulled while green, otherwise the cobs are left until the leaves surrounding them become shrivelled. Proper drying and storage of the freshly harvested crop are of very great importance as the seeds are most liable to weevil attacks.

In several respects maize lends itself as a catch-crop. In the first place it is an annual, which occupies the land for a few months only, and this is an important attribute as an intercrop with young rubber. It is possible to continue the ordinary estate weeding and permits of periodic deep cultivation if required. The remaining stubble when changkolled into the land would improve considerably the mechanical condition of both light and heavy soils and this combined with the improved tilth should compensate for the material removed in one or two harvests. This would apply to other cereal crops but not to the same extent with root crops. The growing of this cereal, or others mentioned below, might be seriously considered by those who have the necessary requirements for their proper culture.

RICE.

I do not propose to deal with this cereal as its importance in Malaya is well known but I would like to mention that hill paddy and other native food crops, such as millet, Job's tears, etc., open up more possibilities than has hitherto been supposed.

JOB'S TEARS.

Thrives well in this country and is cultivated to some extent by the Malays. The grain of the cultivated variety is said to be sweet and wholesome and amenable to ordinary methods of milling. Certain forms of the grain are roasted, then husked and eaten whole and used to some extent as a substitute for rice.

MILLET.

A fairly good crop from a small area of the common millet was harvested at the Kuala Lumpur Government Plantation. The seed is sown broadcast on prepared land and lightly covered. The crop takes about four months to mature. The grain is considered digestible and nutritious and is eaten whole, being cooked like rice.

GROUND-NUTS.

The Spanish pea-nut, small Japanese, Senegal, Mozambique and Tambo ground-nuts have been experimented with at the Kuala Lumpur Government Plantation at different times with varying degrees of success. The time of sowing and harvesting are most important factors as regards yields. Planting must be done during a wet period but at such a time that the plants reach maturity in the dry season. I may safely say that a good yield will not be obtained should the crop be lifted during the wet season, the seed at such a time is not fully ripened and most subject to rot. Harvesting in dry weather is essential. Previous to sowing, the land requires to be lightly forked or changkolled, but not too deep, as the nuts would then be liable to be formed at a greater depth and thus increase the cost of lifting. The nuts are shelled and the seed sown at distances of 18 in., apart each way. Personally I favour planting on ridges as I think a more reliable and constant crop is obtained than on the flat, the nuts are not so liable to rot and the cost of lifting is less. Little after-cultivation is necessary beyond surface weeding but this must be carefully done, so as not to interfere with the nuts which are developed at a small depth under the soil. Three to five months, according to variety and nature of soil, are required to produce a crop. A light friable soil is best suited. The nuts are collected when the leaves begin to wither. If the seed is to be kept for any length of time it must be well dried in the sun before being stored. The Bambara ground-nut, the fruit of which is somewhat similar to the ordinary ground-nut *(Arachis hypogœa)*, did very well and is perhaps more suited to this country as it is not affected to the same extent by seasons. Ground-nuts may conveniently be grown as an intercrop.

I will now refer to a number of root crops, the cultivation of which is sadly neglected here. It is surprising that residents who have in most cases every facility for growing them do not as a rule produce such foods for their own tables, particularly those at any distance from a market.

YAMS.

Some 20 varieties of yams were introduced from India, Ceylon and Barbados and experimented with by the Department. I have no hesitation in stating that they can be successfully grown in Malaya; the weight of individual tubers compares favourably with those of other countries and no special difficulty is experienced in their culture. Suitable soils are sandy loams but deep cultivation and good drainage are more important than quality of soil. The land should be forked or changkolled to a good depth in order to enable the tubers to develop properly. The soil is then put into ridges 3 to 4 feet

apart and the seed tubers planted on the ridges at distances of from 1½ to 2½ feet depending on the variety. The object of raising the ground is to ensure better drainage, to do away to some extent with deep trenching and to make the conditions for lifting the crop more easy. In this country planting could be done at any time but the wet season might be taken advantage of. Near each plant is placed a stick for the creepers to grow upon. The stick should be from 12 to 16 feet high. A common practice is to plant up trees for support. It is not uncommon to allow the plants to trail on the ground but this method is supposed to decrease the yield slightly. The crop takes from nine to eleven months to mature. At the end of this time the leaves become brown and drop, and the stem dies down; this indicates that the tubers are ready for lifting. The tubers should be lifted as required, as they do not keep long when exposed to the atmosphere, but when left in the ground they keep for quite a long period. The yields depend on the variety grown, suitability of soil, cultivation, etc., but generally speaking it varies from 4 to 10 tons per acre, approximately the same as the yield of potatos. In Malaya, yams are seldom if ever seen, but in the West Indies, particularly, they form a standard diet both for Europeans and natives, the latter living largely on this food. Being more nutritious than the potato they form one of the most important foods of the tropics. In several countries they take the place of the potato and are considered by many people superior to it. They have been frequently recommended for extended cultivation in India in times of famine as they are not affected by long periods of dry weather. In such countries as Malaya, where a large proportion of the population is almost entirely dependent on the rice crop for their food, yams might, when the price of rice is high, partly serve as a substitute.

SWEET POTATOS.

These are often looked upon as yams but this is not the true use of the word. The type of soil and the depth of cultivation required are similar to those for the yam. They may be grown on flat ridges 3 feet apart. The stem cuttings are planted on top of the ridges at distances of 1½ feet, but when grown on the flat the cuttings are placed 2 feet apart each way. The tubers may also be used for propagation purposes but the former is the general method. The crop is best lifted during dry weather.

JERUSALEM ARTICHOKE.

This root crop, which is easily grown, does exceedingly well in Malaya and gives very good yields, probably as large as in any country. The soil is deeply cultivated previous to planting and maintained clean during the period the crop occupies the land. The best time for planting is just as the young shoots are appearing on the tubers and is done at distances of 2 feet. The crop takes from three to four months to reach maturity. The tubers are ready for the table when the leaves begin to wither and dry. The plants thrive well in most situations but preference should be given to reasonably rich soils.

VIGNA CATJANG.

This bean has for a number of years been successfully grown at the Kuala Lumpur Government Plantation. There are several forms of the plant, the one commonly grown in this country by Chinese market gardeners has long pods and is often sold as a substitute for French beans. The crop is

ready for collecting in about two and a half months. It does well on light and alluvial soils or loamy lands. When cultivated on a small scale it is generally grown in prepared nursery beds, the seed planted in rows 18 inches apart, the young plants being trained to grow upon sticks, two or three plants to each stick. In India the seed is sown broadcast on prepared land.

TAPIOCA.

Tapioca has been grown fairly extensively in Negri Sembilan and Pahang in the past few years, the export from the former State during the years 1914 and 1915, being 21,585 pikuls and 17,235 pikuls, respectively. If grown for any length of time on the same area, manuring will ultimately have to be resorted to as a means of securing good yields and for this reason it is best grown as a sole crop. In Pahang it is cultivated fairly extensively as a catch-crop amongst young rubber but I am extremely doubtful if this is to be recommended. Tapioca is propagated from stem cuttings, 6 inches long, the cuttings being half buried in the soil in a sloping direction at 4 feet distances. The crop takes about one year to reach maturity.

SUGAR-CANE.

I merely wish to refer to this as a food substance which was extensively grown in Province Wellesley at one time and to a smaller extent in other parts of the country. The growing of sugar-cane as a plantation crop here is now non-existent but it is cultivated to a minor extent, especially by market gardeners.

SAGO PALM.

This palm is a native of Malaya and yields the sago of commerce. It is found chiefly in swampy flat situations and is particularly common in some parts of Perak and Negri Sembilan. There are fairly extensive areas where this palm would flourish and which perhaps, with the exception of paddy, are unsuited for other tropical products.

FRUITS.

Before closing this address I would like to refer briefly to the question of fruit culture. This important branch of agriculture is largely ignored by the European planter. There are a considerable number of fruits which flourish here, but few private gardens have anything like a representative collection. Suitable lands in the neighbourhood of the larger towns, might be profitably utilized for the growing of fruit trees for I feel sure that a ready market would be secured.

The following fruits can be successfully grown in Malaya: custard-apple, bullock's-heart, soursop, cherimoyer, mangosteen, roselle, durian, blimbing, carambola, pumelo, lime, citron, orange, langsat, duku, rambutan, pulassant, avocado pear, chiku, *Passiflora laurifolia* and papaya. The following fruits show some promise: Java almond, Cashew-nut, pomegranate and wood-apple.

VEGETABLES.

The following vegetables are worthy of extended cultivation: lettuce, endive, kohl-rabi, snake, bolli and wax gourds, cucumber, tomatos, spinach, carrot (short horn varieties) *Coleus tuberosus*, brinjal, yam-beans and arrowroot.—AGRIC. BULL., F.M.S., VOL V. No. 11 and 12, Aug. & Sept.

LASIA ACULEATA Lour.

"KOHILA" S.

This plant described and determined as *L. heterophylla*, Schott, or *L. spinosa*, THWAITES, in various floras is the only species of its genus. HOOKER in TRIMEN'S *Flora* states that it is not found in Peninsula India. It is a typical marsh plant belonging to the Natural Order *Araceæ* and should be regarded as a very representative member of SCHIMPER'S "rain-forest" of Indo-Malayan origin. Its distribution in Ceylon is recorded as " rather common" in the moist low-country.

The note recorded in TRIMEN'S *Flora* under this plant—"Rootstock eaten in famine times"—does not sufficiently bring out its economic importance. All parts of the plant and preferably its young tender leaves are very much relished as a vegetable curry with boiled rice. The reputed medicinal qualities still further enhances its value and it always finds a very ready sale. The plant should be noted as a very valuable one to grow on waste marshy places or in paddy land that cannot for one or more reasons be utilised for the growing of rice. In such land especially if the soil has more sand than clay the plant will readily establish itself and form an impenetrable thicket.

The writer had occasion to visit an area little more than 2 miles from Peradeniya where a "kohila" plantation has been established. The whole area under this plant was perhaps slightly more than quarter an acre in extent. It was divided into two blocks one of which is stated to be about 30 years old whilst the other which was planted up with cuttings from the first block is stated by the owner as being planted by himself about 12 years ago.

The plantations are established on the higher terraces up the valley where the deposit of silt is least. The soil has a surface layer of coarse sand, the silt being obviously washed down to lower levels.

The establishment of a plantation is very simple, consisting merely of the planting of stem-cuttings 1½ feet apart. It is advisable to lay out foot paths a foot wide at intervals of 3 feet as otherwise harvesting will be a painful and laborious operation. The whole plant is armed with spines and the stems being creeping and ascending interlace so as to form a thick impenetrable mass.

The plantation is in full bearing eight months after planting. The harvesting consists in the removal with a knife of the young tender leaves (before they unfold out) from the sheathing bases. This is done once in every seven or eight days. The yield from the plantations visited was given as 75 to 100 bundles at a time. Assuming that the leaves are harvested 40 times every year with an average outturn of 80 bundles, the yearly yield works out as 3,200 bundles. In this particular instance a villager buys the whole crop at 1½ cents a bundle and retails it at 2 cents a bundle. The yearly returns can thus be estimated to the owner as Rs 48/- on quarter an acre or nearly Rs 200/- on an acre. The villager who buys up the whole crop finds no difficulty in disposing it off in Peradeniya itself. He rarely goes to the Kandy market and then only when prices are good. Each household buys anything from 1 to 3 bundles for a meal and since the tender leaves can keep fresh in water for about 2 days, it is easy to dispose of 6 to 10 bundles to many houses. Thus for one morning's work this villager realises nearly 50 cents net profit which might be considered a day's wages—a result highly satisfactory to the retailer.

The flowers appear in December-January and are harvested together with the tender leaves. They are also put in amongst the bundles and sometimes sold at a slightly higher price (e.g. ½ cent more for a bundle.) The fruit which consists of an aggregate of berries is also eaten but never sold as it is too fibrous to be relished as a vegetable. The stem and root-stock is sometimes sold after the plantation is thinned out. It is preferred more as a medicine than a vegetable. It has a high reputation as a remedy for piles. About one pound of the green rootstocks are washed free of soil, etc., and pounded to extract the juice. This makes up a dose of about half a pint and is drunk raw.

WATT records in the "Agricultural Ledger" that CAMPBELL reports the root as "highly esteemed by the Santals as a remedy for affections of the throat."

Two varieties of the plant are recognised by the villagers according to the shape of the leaf. "Ath kohila" has hastate or sagittate leaves with an entire margin. "Relou kohila" has very much divided leaves, characteristically pedately pinnatifid with the segments lanceolate. This must be reinstated as ENGLER's variety *B. Hermanni*. Whilst the leaves are variable still the description of the leaves in TRIMEN's *Flora* is not correct, e.g., "young, hastate or sagittate, old, pinnatifid, etc." "Ath kohila" which may be regarded as the type has entire hastate to sagittate leaves when old. Its leaves are less succulent than the other variety and even when variable can be readily distinguished from the other.

HENRY L. VAN BUUREN.

MI FLOWERS AS FOOD.

In some parts of the Island (e.g., Bilihuloya in the Ratnapura district) the villagers use the flowers of the Mi tree *(Bassia longifolia)* for food in the same way that certain classes in India utilize the flowers of the Mahwa (*Bassia latifolia*).

The flowers are first dried in the sun and then "thrashed" with a stick to rid them of a "powder" (pollen ?) which is said to give them a bitter taste. They are next ground down and mixed with rice flour and shredded coconut kernel, and afterwards cooked by steaming. In the dry condition the flowers have a strong but not unpleasant odour and are sweet to the taste with something of the flavour of raisins.

A sample of the dried flowers was sent to MR. M. K. BAMBER, GOVERNMENT AGRICULTURAL CHEMIST, for examination, and his analysis gave the following result :—

Moisture	27·20 %	Nitrogen	0·72 %
Ash	2·28 %	Nutritive ratio	1:14·5
Ether extract	·90 %	Food units	76·4
Woody fibre	2·20 %	Total water extract	61·4 %
Cane sugar	16·40		
Sugar & dextrose	34·70		
Starch	11·82		
Proteids	4·50		
	100·00		

MR. BAMBER adds "the sample seems to be particularly high in sugar."

C. D.

RESULTS OF LOCAL TRIALS WITH CURRY STUFFS.

AT MATALE.

The following report by MR. R. SENIOR-WHITE on trials made by him with curry stuffs on Suduganga Estate, Matale, gives interesting information:—

RED GRAM.

Planted 6 ft. × 6 ft. from seed at stake. The plants are now some 4 ft. high, and very healthy. There is no sign of flowering as yet. Is attacked by a stem borer, causing branches and stems up to finger thickness to break in a high wind. An insect is undoubtedly present, but I have failed to find it after a branch has broken. The leaves are attacked by a Geometrid *Pseudoterpna chlora* and the Arctiid, *Pericallia ricini*. The heavy winds at the end of September have brought out the fact that this should not be planted in a windy location. Quite apart from the stem damage by an insect referred to, there was much breakage by wind alone.

BLACK GRAM ("Ulundu," S.)

Planted 3 ft. × 3 ft. This is too distant, and 2 ft. 6 in × 2 ft. would be better. Plants now in flower. Leaves attacked by a Lymantriid, *Dasychira fusiformis*.

HORSE GRAM ("Kollu," S.)

Planted 3 ft. × 3 ft. This is also too far, and 2 ft. × 2 ft. is sufficient. Pods now commencing to ripen.

CORIANDER.

Planted 1 ft. × 1 ft. Very heavy yield. Crop nearly finished gathering. Does not appear to suffer from any pest.

ANISEED ("Maha-Duru," S.)

(Tamil, Peria sheeragam). Planted 1 ft. × 1 ft. Now in flower. Growth excellent. Leaves eaten by Noctuid, *Plusia orichalcea*, and Geometrid, *craspedia fibulata*.

CUMMIN ("Sudu-Duru," S.)

(Tamil, Sinna sheeragam). An absolute failure. I twice tried to put out the seedlings, but without exception they died on each occasion. However, judging from the experience with aniseed, the larger plant, I think that S. A. I. MOLEGODE was in error in advocating planting 2 ft. 6 in. sq in *T. A.* of June.

FENUGREEK ("Ulubal," S.)

Planted 6 in × 6 in. This would appear to be too far for the growth made here. The crop is now being gathered, and the yield would not appear to be high, though of good quality.

MUSTARD.

The imported seed supplied was entirely killed out on two occasions, first by the Pyralid, *Hellula undalis*, and second by a Pentatomid, probably *Bagrada picta*. Only one plant survived, and has set seed, which I am keeping separate in the hope of obtaining a strain as resistant as the local mustard, which does not seem to be touched by *Bagrada picta*. I have now got the plots planted out in local seed from the kaddies in Matale, which was doing well, but was subsequently destroyed by the

Tineid *Plutella maculipennis*, the Pyralid *Crocidolomia binetalis*, the Arctiid *Pericallia recini*, and the Noctuid *Prodenia litura*. The Pentatomid, *Bagrada picta*, also appeared in small numbers. The crop is hardly a sufficiently valuable one to spray, which in any case would not be done by the villager, while the 3 chief pests, *Hellula undalis*, *Plutella maculipennis* and *Crocidolomia binetalis* are of such small size that effective handpicking is out of the question. Possibly if grown on a field scale the damage would not be so great.

GINGER.

Growth good. I find from previous experience that with the ordinary chena soil of this district, river sand should be liberally added to the beds, though the cost of this operation would probably confine the cultivation, as far as the villagers are concerned, to sandy places.

DHURRA.

I am now raising the seventh generation of seed selected for its white colour and erect panicle.

BOMBAY ONIONS.

These are as usual doing well here. Following on my manuring figures published in the last Progress Report of the Ceylon Agricultural Society (p. 79 of T. A. August, 1917) I can now advise that Superphosphate 400 lb., Nitrate of soda 200 lb. per acre makes a good commercial application.

CHILLIES.

I shall shortly have selected seed of four varieties. The large round American capsicums, which here attain after selection the size of a tomato, have attracted considerable attention among such villagers as have seen them.

AT HETTIPOLA EXPERIMENT GARDEN.

SEASON 1916-1917.

GREEN GRAM (*Phaseolus radiatus* var. Mungo).

Size of plot—¼ acre.

Sown.—4th October, 1916—Broadcasted.

Seed rate.—One measure.

Harvested.—14th January, 1917.

Yield.—38 measures (38 fold).

Remarks.—Growth good. A certain amount of damage was done in the early stage by village fowls and later by pigs. If not, yield would have been better as the plants grew up and branched well. No pests.

DHURRA. Size of plot ¼ acre.

Sown.—21 November, 1916. In holes a foot apart 3 or 4 seeds per hole. Later thinned out to one.

Seed rate.—1/3 measure.

Harvested.—15th March, 1917.

Yield.—42 measures.

Remarks.—Yield not satisfactory. Damage caused by birds

RUBBER.

THE PREPARATION OF PLANTATION PARA RUBBER WITH SPECIAL REFERENCE TO FUTURE CONSIDERATIONS.

B. J. EATON, F.I.C., F.C.S.,

Agricultural Chemist, F.M.S.

It is proposed in this paper to submit very briefly the results of the researches on raw rubber manufacture which have been conducted for the past 2½ years at the Agricultural Department by the writer and his assistants and to consider in what way these results are likely to affect the future methods of preparation of the raw product, having in view both the highest quality of rubber which can be prepared and the manufacturers' requirements, as far as we have been able to obtain information in this respect.

As a starting point two axioms are propounded, with which I think every planter and manufacturer is now in entire agreement.

They are (1) The highest grade of wild rubber, viz., Fine Hard Para, which is the premier raw rubber among wild rubbers, so called, on the market, is very uniform. (2) Plantation Para rubber from the cultivated Hevea is very variable. Arising out of both of these axioms we have now to consider : (a) In what respect is plantation Para rubber variable and how can this variability be remedied ? (b) What are the causes of the variability in the case of the plantation product and what the reason of the uniformity of the product from the uncultivated tree ?

I do not propose to enter into any details as to the researches which have enabled us to elucidate to a considerable extent these important problems, since much has already been published by the writer and his collaborators and since confirmed by other independent workers and in a month or two a special illustrated bulletin will be published giving the details of these researches to date. It is only necessary here to summarize the results obtained and, if further information is required on any special point, this may be probably obtained during the discussion of the paper.

Speaking historically, the remarks expressed by MR. WILLIAMS, Works Superintendent of the North British Rubber Company, one of the leading and most advanced of our British rubber manufacturing firms, especially in the organization of scientific research, will form a suitable text on which to hang this discourse. These remarks which were made at the 4th International Rubber and Allied Trades Congress held in London in July, 1914, were as follows :

"My experience is that quite apart from all questions of strength, the question of the vulcanizing properties of plantation rubber is the greatest trouble the manufacturer has to face. Without efficient control, faulty vulcanization undoubtedly will be responsible for loss of time and money. These troubles, in factories where scientific control is not thoroughly organized, may be sufficient to condemn the use of this grade (that is plantation rubber, B.J.E.) entirely."

Since that date we have travelled far in our knowledge of the vagaries of this wonderful substance and one can say it, with a certain amount of pride, without being egotistical, that the Agricultural Department of the Federated Malay States has had the honour and good fortune of contributing the most important and fundamental researches on the problem.

The above remarks by MR. WILLIAMS constitute the first intimation from the manufacturer of the nature of the variability of plantation rubber. These remarks were confirmed at the same Congress by DR. SCHIDROWITZ in a paper entitled "Variability" in which figures for numerous cases of such variability were published. Independently, later in 1914, our early researches led to the same conclusions: since which we have been able to discover the cause or causes of the variability and many of the contributing factors in connection with estate factory practice which have an influence on variability.

It can therefore in the first place be enunciated that the principal defect of the plantation product is its variable behaviour during vulcanization, or to put it in the technical terms used by the rubber manufacturer, variability in rate of cure or speed of vulcanization.

The remedy, i.e., the method of obtaining uniformity in this respect, can only be attained after a realization of the cause, and the great aim of scientific research is to connect cause and effect in the world of nature. It may however be argued logically, assuming that variability is due chiefly or entirely to methods of preparation rather than to intrinsic differences in the latex on different estates of from different areas or districts, that uniform methods of preparation will ensure uniformity of product, but even so, we are at much greater advantage if we possess a knowledge of the cause, since it may then be essential only to adopt uniform methods in one or two respects. Secondly a knowledge of the cause of variability will enable us possibly to prepare an improved type of the raw product, having realized that our existing methods are entirely empirical and like "Topsy" have merely "grown."

Fortunately a knowledge of the cause of variability deduced from our researches, enables us to state that variable methods of preparation are chiefly, if not entirely, responsible for variability of the product, and this being so, we are more easily able to apply a remedy which consists in uniformity of method of preparation. Further the information derived from the elucidation of the cause of variability has enabled us to realize the second problem, viz., the preparation of an improved type of raw rubber and it is essentially with this problem that I propose to deal.

Returning once more to the cause of variability, we have found that variability in rate of cure of the raw product is brought about by two factors: (1) the amount of an accelerator or catalyst produced in the raw rubber from the nitrogenous constituents of the latex by allowing the coagulum to mature for about six days before machining, and (2) the amount of some accelerating substance in the latex which is retained in the rubber by some process of preparation in which all the serum is retained.

The first of these substances, which has the greatest influence, especially in small quantities, we have found to be some decomposition product of the nitrogenous constituents. The second substance exists originally in the latex and is removed almost entirely when the fresh coagulum is converted shortly after coagulation to thin crepe.

In dealing with the first of these factors, I propose only to summarize the factors which will influence the amount of such accelerator in the rubber. They are as follows :

(1) Amount of moisture in the prepared rubber;

(2) Amount of serum retained ;

(3) Rate of drying ;

(4) Thickness of coagulum before and after machining ;

(5) Presence of antiseptics, e.g., formalin, sodium sulphite and sodium bisulphite ;

(6) Influence of different coagulants ;

(7) Excess of coagulants, especially of certain coagulants ;

(8) Influence of smoking ;

(9) Influence of artificial methods of drying ;

(10) Action of various chemicals on the finished rubber in retarding or accelerating rate of cure ;

(11) Concentration of latex ;

(12) Effect of water as a solvent.

In dealing with the second accelerating factor the factors which influence the amount present are :

(1) Concentration of latex ;

(2) Effect of water as a solvent on the finished rubber.

Whether other factors, such as the nature of the coagulant, or an excess of coagulant, antiseptics and other chemicals or smoking, have an effect on rapidly curing rubber, the rapidity of cure of which is due to some constituent of the latex normally removed in the serum by the machining of fresh coagulum has not yet been ascertained, but is probable. In support of this we have the fact that Fine Hard Para which is comparatively slow curing, contains all the serum constituents and should be rapidly curing, but the vulcanization is retarded by the smoking process.

Dealing briefly with the factors involved in the variability of the first type of rubber in which the vulcanization is accelerated by the amount of some protein degradation product formed during the maturing of the coagulum by natural biological processes, the following factors accelerate rate of cure :

(1) High moisture content up to a certain limit ;

(2) Large amount of serum ;

(3) Thickness of coagulum up to a certain limit, which affects the rate of drying ;

(4) Slow drying ;

(5) Concentration of latex ;

(6) Action of certain chemicals, especially the alkalis, soda and potash and their carbonates.

The following factors retard the rate of vulcanization :

(1) Low moisture content in the prepared coagulum ;

(2) Removal of serum ;

(3) Rapid drying ;

(4) Thinness of coagulum which produces rapid drying and is also responsible for the removal of serum by machining ;

(5) Presence of antiseptics, especially formalin, also boraic acid and tannic acid ;

(6) Certain coagulants, e.g., the mineral acids especially hydrochloric, sulphuric and hydrofluoric acids and certain salts especially the alums ;

(7) Excess of coagulant—the effect of excess of weak organic acids, such as acetic, formic, citric, tartaric and oxalic is not very marked, while excess of the mineral acids has a marked retarding effect ;

(8) Smoking ;

(9) Artificial methods of drying—not very great in the case of thin crepe, which is the only type of rubber subjected to artificial methods of drying ;

(10) Dilution of latex with water ;

(11) Action of water as a solvent.

With regard to the second factor responsible for variability in rate of cure the influence of various factors in retarding the rate of cure has not yet been investigated, but it is probable that smoking, mineral acid coagulants and alum and other antiseptics and chemicals will retard vulcanization.

THE UNIFORMITY OF FINE HARD PARA.

In my opinion the sole reason for the uniformity of Fine Hard Para is the law of averages. Each ball of Fine Hard Para probably takes from one to two months to prepare and thus any daily variation of the latex in concentration, etc., or any variation in the temperature or other conditions of the smoking process employed, are averaged. This indicates at once a method for rendering plantation rubber more uniform in bulk, viz., the mixing together in each case, of rubber prepared on different dates.

Having summarized the causes of variability in plantation Para rubber and shown the principal factors which have an influence on the problem and stated the probable reason for the uniformity of Fine Hard Para, it can easily be seen what remedies should be adopted to secure uniform results. It is obvious that the problem is not excessively difficult on any one estate for one type of rubber, but that considerable difficulties arise in the endeavour to make all estates carry out a similar practice.

In considering the problem of variability we must at once realize that uniformity can only strictly apply to one type of rubber. Thus thin pale crepe is intrinsically distinct from smoked or plain sheet and as long as there is a market demand for this grade, which will probably be always, since this type of rubber has created its own market for specific purposes for which no rubber of darker colour could be employed, it is impossible for estates to make one uniform product, since thin pale crepe, from its mode of preparation will almost certainly always have a different rate of cure to smoked sheet. It might be suggested that this type of rubber be made as the sole first grade. The answer to this is that thin pale crepe is almost always inferior to smoked or plain sheet in tensile properties and hence should not be used for articles in which strength rather than colour is a desideratum.

It is thus evident that for present demands we must prepare at least three and probably four grades of plantation rubber, that is either two first grade

and one second grade or two first grade and two second grades. The probability is that four grades is the minimum, since it does not seem desirable from our researches to combine all lower grades. The best solution is probably the preparation of pale crepe and one other first grade and the preparation of two lower grades as follows: No. 1 lower grade crepe to consist of lump, skimmings and picked scrap, and No. 2 lower grade crepe of bark shavings plus earth scrap.

It is not proposed here, however, to deal with lower grades but with first grades only, although in one respect, the question of "lump" rubber or cup and bucket coagulations, is of interest, as will be seen later.

The problem therefore with which we have to deal in connection with the preparation of first grades, is whether we are going to be content to produce pale crepe and smoked sheet as carried on at present or to endeavour to substitute another and an improved type of rubber in place of smoked sheet and it is this problem primarily with which I propose to deal briefly, leaving the subject open for discussion, after bringing forward the salient facts in support of a new method of preparation.

It would probably be preferable to state at once that the proposed method of manufacture is that which we have styled "slab" rubber, in lieu of sheet.

Our researches have shown that whereas smoked sheet cures in about $2\frac{1}{2}$ to $3\frac{3}{4}$ hours under the conditions employed, "slab" rubber cures in about $1\frac{1}{4}$ hours or less than half the time. Apart from this, "slab" rubber is about 20 to 25 per cent. superior in tensile properties to crepe and generally superior to smoked sheet. The advantages to the rubber manufacturer of this type of rubber are therefore obvious. Whether a manufacturer would be prepared to pay a premium for such rubber however remains to be seen and for the present it is taken for granted that such rubber would merely fetch the ordinary top market prices obtained for smoked sheet. We, therefore, have to consider its preparation entirely from the producer's point of view (assuming of course that it is not going to fetch a lower price on the market. as it probably would do if judged by appearance only). What are the advantages we must ask ourselves of any alteration of existing methods, Some planters may be very conservative in this respect and prefer a *laissez-faire* policy, but I venture to suggest that, especially at this time, we have no more right to adopt such a policy in our commerce and industry than we have in the conduct of our military affairs and I therefore assume that all planters are alive to the necessity of a change if it can be shown that such a change will produce an improved product.

We have now to consider the possible forms in which such a type of rubber can be prepared, taking note of the advantages and disadvantages of each method of preparation.

There are only three possible forms in which such rubber could be prepared for the market, viz.: (1) virgin "slab" containing about 20 per cent. of moisture, (2) in the form of crepe, (3) in the form of dry block.

Of these forms the most suitable when everything is taken into consideration is the first. The only disadvantage of shipping virgin "slab" is that extra freight has to be paid on about 20 per cent. of water.

The pre-war freight on rubber was about $\frac{1}{2}d.$ or say 2 cents per lb., while the present rates are about $1d.$ or say 4 cents per lb. If rubber containing 20 per cent. or at a maximum, say, 25 per cent. of water is shipped the actual amount of dry rubber sent for 2 cents at pre-war rates would be 80 or 75 per cent., respectively, that is to say, each pound of actual rubber

will cost $2\frac{1}{2}$ cents or $2\frac{2}{3}$ cents at pre-war rates and 5 cents or $5\frac{1}{3}$ cents at present rates of freight. This represents an extra cost on freight of $\frac{1}{2}$ to $\frac{2}{3}$ cents at pre-war rates and 1 to $1\frac{1}{3}$ cents at present rates.

This extra cost has now to be compared from an economic point of view with the cost of preparing, say, smoked sheet in estate factories and this cost is represented when compared with "slab," by the actual cost of machining, since acetic acid or some other coagulant has to be used in the case of both "slab" and sheet.

The lowest factory costs for present first grades is probably about 1·5 cents per lb. which includes oil for engines and acetic acid, but does not allow for capital cost and depreciation of machinery and factory. In the preparation of "slab" rubber, apart from the machinery required to treat 20 to 30 per cent. of the crop which is represented by lower grades, all machinery and consequently a large factory is eliminated.

Leaving aside, however, the depreciation on factory and machinery, the cost of preparation of first grades is probably not lower than the above figure and in the preparation of virgin "slab" rubber the saving effected in cost of preparation will at least compensate for the extra freight even at present rates, while in most cases and at pre-war freights the saving in cost of preparation will probably be from 1 to 2 cents per pound on many estates.

The above figures have demonstrated that virgin "slab" is cheaper to prepare, requiring little care, apart from cleanliness, and that the saving on cost of preparation more than compensates for the extra freight charges on moisture.

Two other disadvantages may be mentioned, viz., difficulty of fixing duty owing to a possible variable moisture content, and secondly the introduction of a new type of rubber may cause confusion among manufacturers. The first of these would be capable of adjustment in a short time and present no greater difficulty than does Fine Hard Para while the second is not worth taking into consideration, since the manufacturer would soon realize the value of this type of rubber.

With regard to the shipping of "slab" rubber in the form of crepe, there is no advantage to the producer, in fact possibly a slight disadvantage in that the coagulum after maturing for six days is very tough and therefore more difficult to machine. The advantages lie entirely with the manufacturer who is obtaining a better type of rubber, which is clean and dry, and probably may not, if properly packed, require rewashing.

One disadvantage which has been suggested is the difficulty of distinguishing such crepe from many specimens of ordinary slow curing crepe, except from first latex pale crepe. This is easily surmounted, however, by labelling boxes, as is done at present for different grades and styling the rubber "slab" crepe or some other fancy name. As a disadvantage it is not worth the consideration of either scientific or practical men, to use a distinction to which I object.

The third method, viz., shipping in the form of dry block, presents one or two advantages, especially from the producer's point of view. In the preparation of dry block, the rubber has to be creped thin, wormed on a special cutting machine, vacuum or hot air dried in this form and then pressed into blocks. Assuming we are leaving the coagulum for seven days, crepeing can be carried out on the 8th day and the rubber prepared ready for shipping on the 9th day. A great saving in factory space is thus effected and also in packing space. It is recommended that the blocks be made

about 1½ to 2 inches thick. Rubber prepared in this manner has been examined in our laboratories nearly two years ago and found to give excellent results.

There is, of course, no improvement of quality in such block, the question being entirely one of economics.

The disadvantages, of course, of preparing the rubber in this form are very similar to those in the case of preparing and shipping as thin crepe, except that drying space and packing space is saved.

I trust that the facts stated above will, especially at the close of the present war, when manufacturers are able to return to more normal conditions and to carry out experiments, stimulate further interest on the part of both of the producer and manufacturer in a problem which has not only proved very fascinating as a piece of scientific research, but which is, in my opinion of supreme importance.

It may be useful to state in conclusion that manufacturers have expressed considerable interest in the results obtained and on all sides have added confirmation to the results obtained at the Agricultural Department.

One other factor, to which reference has been made before, in connection with the advantage of preparing "slab" rubber, is that lump or cup and bucket coagulation can be mixed with first latex rubber, since this rubber if left for the maturation period before crepeing is essentially "slab" rubber. This means, therefore, an increase of first grade rubber, and should prove especially valuable on those estates where natural coagulation is abnormally great.– AGRIC. BULL., F.M.S., VOL. V. No. 10, JULY 1917.

SEED SELECTION IN HEVEA.

With reference to the article on seed selection in the cultivation of *Hevea brasiliensis* reproduced in the TROPICAL AGRICULTURIST for May 1917, the following memorandum prepared by MR. T. PETCH, Botanist and Mycologist, for transmission to Kew is of interest:—

The question of seed selection in *Hevea* was a subject of discussion at the Ceylon Rubber Exhibition in September, 1906, and one of the deciding factors in the appointment of the late DR. R. H. LOCK as Assistant Director of the Royal Botanic Gardens, Ceylon, a year later, was his recognised standing as an authority on plant breeding. Systematic experiments of rubber-tapping were begun in 1908, on the old trees at Henaratgoda, then the only tappable trees under the control of the Botanic Gardens, and when it has been established that tree No. 2, at Henaratgoda steadily yielded an amount of rubber far in excess of any of the other trees in tapping, steps were taken to plant up an area with seed of that tree. There are now three acres of *Hevea* on the Experiment Station, Peradeniya, planted with that strain. The oldest (2 acres) was planted in 1912, with stumps one year old, and is not yet tappable. The intention at present is that when these trees are fit for tapping they will be tapped to determine which of them are good yielders; the poor yielders will then be cut out, and the area reserved for seed. It is of course recognised that investigations on the subject of the inheritance of latex capacity may compel modifications of the scheme.

Other experiments at Henaratgoda have yielded a mass of data, which owing to the reduction of the scientific staff, has not yet been analysed. For example, an experiment was begun in 1908 on seventy trees tapped at different (time) intervals, in groups of ten. Through the removal of a shelter belt, several of these were blown down in 1913, but there still remain

some fifty trees whose individual latex yield has been recorded for every tapping since June, 1908, the trees having been tapped continuously at regular intervals, varying in the different groups from one to seven days. And there is a large number of trees whose individual latex or rubber yield has been recorded for periods of one to two years. It is, therefore, scarcely correct to state that no attempt has been made to obtain reliable data as to the variation in yield of latex and rubber from individual trees.

In 1912, an attempt was made to attack the problem from another side, viz., to determine whether the latex-yielding quality can be associated with any definite botanical character, and to what extent such characters are transmitted.

On this subject, the individual planter generally has very definite views, but few agree with one another. In Ceylon, three types of bark are usually distinguished, smooth, moderately corky, and very corky. The smooth-barked tree is often regarded as a poor yielder, and this appears to be true, if the smooth exterior is associated with a yellowish and somewhat granular internal structure. But there is some evidence that the external appearance of the trees, in Ceylon, varies with the elevation of the plantation. Differences in the foliage have also been associated with latex yield, the small-leaved tree being regarded as a poorer yielder than the large-leaved form. On the other hand, the large-leaved tree appears to suffer more from the leaf-fall caused by *Phytophthora* than the small-leaved, though it remains to be determined whether this is merely due to the fact that the loss of the same number of leaves makes a greater difference in the appearance of the tree in the former. There is also a tree with a dark glossy leaf which contrasts strongly with the normal leaf, a fact which may prove of service in the matter of disease resistance. With regard to the colour of the bark, it was stated in Ceylon some ten years ago that trees with a pink bark were poor yielders. On examination it was found that the pink external coloration was due to the presence of a red alga *(Chroolepidæ)*, which finds a better footing on smooth than on rough-barked trees. This accords with the late DR. HUBER's statement that the difference between the white and the black *Hevea* of the Amazon is due merely to the growth on the stem of different species of lichens, according to the exposure of the tree.

Seeds were selected in 1912, from trees which showed well-marked characters, seeds and leaf characters being chosen as a beginning. The experiment however was regarded as a purely scientific fad, and the subsequent treatment of the plants was such that it has small prospect of result. A large number of trees is required, before any definite conclusions can be based on such experiments, and this necessitates the occupation of an acreage which at the present time is not available.

A small experiment which may afford preliminary ideas on the relation of yield to botanical characters has been in progress for nearly a year. Twenty trees of the same age, growing in a four-acre block at the Experiment Station, Peradeniya, have been selected for difference in leaf or bark characters. These are all tapped on the same system, and the yield of rubber from each tree is recorded separately for every tapping.

Reference may also be made to the investigations on *Hevea* cortex by MESSRS. BRYCE and CAMPBELL which were designed ultimately to discover whether any relation existed between structure and yield. Preliminary bulletins have been issued, but the work has now lapsed owing to the departure of both these officers on military service.

The problem of seed selection in *Hevea* has been attacked by the Ceylon Department of Agriculture from both the empirical and the scientific standpoint, but it is not possible to attain results rapidly, and the rate of progress is necessarily governed by the money and men available for the work.—KEW BULLETIN No. 3, 1917.

SUGAR-CANE.

THE PROBLEM OF SUGAR MANUFACTURE IN INDIA.

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In these days when every effort is being made to make the British Empire self-supporting the question whether the Empire cannot in future do without the beet-sugar grown by the enemy countries is engaging much attention It has recently gone the round of the daily press that the Home Government are out to encourage the cultivation of sugar-beet in the United Kingdom, and that in Jamaica and the West Indies the question of State-aided central sugar factories is being satisfactorily dealt with. It is understood that there is much room for the development of the sugar-cane crop in several British Colonies, and there is every reason to hope that with more intensive cultivation the output will be considerably increased. The sum total of the actual or possible acreage available in the British Colonies is nearly 3 million acres (2,946,675) capable of yielding 4,775,000 tons of sugar.* It can also be safely assumed that sugar will not sink to its pre-war level of prices in the near future as the *per capita* consumption of sugar is increasing almost in all countries, the beet-growing area has suffered severely from this war, and there is no prospect of any immediate great expansion of sugar-cane cultivation in the tropics except in Cuba. Cuba has increased her output of sugar from 300,000 tons to 3,000,000 tons during the last twenty years, and it is believed that there are still large areas of rich land at present unworked which may be utilised for sugar with the American capital and machinery pouring into that country. But since the world's pre-war consumption of sugar was 18 million tons, cane sugar supplying 9 millions and beet-sugar an equal amount, and as the beet-growing area has suffered enormously and will most probably be prohibited from dumping the markets of the British Empire, any increase in the Cuban output will not materially ease the situation. It is held in some quarters that if India alone improves her output, her present acreage of 2,437,000 under cane (with about 175,000 acres under sugar-yielding palms, etc.), will not only enable her to meet her own requirements of both raw and refined sugar and thereby set free the quantity of sugar at present imported, but also to export her surplus produce. It is pointed out in this connection that the imports of over 800,000 tons of refined sugar into India in normal times cannot be supplied by the British Empire without creating a deficiency of supply elsewhere, since the total output of the British Colonies, excluding the home consumption at the producing centres, is only about

* See the Table on p. 6 in "The High Price of Sugar and How to Reduce it," by HAROLD HAMEL SMITH.

880,000 tons. It is to be noted, however, that notwithstanding the high price of sugar due to the war, there has been no increase in the cane cultivation in this country. On the contrary, if we take the statistics of the last twenty-five years, we find that while in 1892 the area under sugar-cane was 2,798,637 acres* there is now a decline of some 350,000 acres as will be seen from the forecast for the sugar-cane crop of 1916-17 which gives 2,414,000 acres† (to which must be added about 23,000 acres from unreported areas where the cane is grown on a very small scale). The industry has declined most conspicuously in Bengal including East Bengal (497,000 acres in 1916-17 against 1,071,200 acres in 1892-93) and also to some extent in the Central Provinces. During the same period the imports of cane and beet-sugar (both refined and unrefined) rose from roughly 100,000 tons to over 800,000 tons in 1913-14, and yet the area under cane in India is steadily growing less. During the last three years of the war, when the imports of foreign sugar shrank from 800,000 tons to 440,230 tons, the area under cane should have expanded proportionately, had refined sugar been a necessity and not a luxury to the majority of the consumers in India, and if a fairly good number of sugar factories installed on modern principles had already been working in the country. The plain facts are that there are few‡ factories manufacturing sugar direct from cane or refining it from palm jaggery or *gur*, and further, even if there had been a desire evinced to open new factories, the serious shortage of tonnage and the difficulties in the way of getting new machinery from abroad were sufficient to make the most enterprising capitalist shy off.

Now what are the peculiar difficulties that the white sugar industry has to contend with in India? Some place in the forefront the class of canes grown in India and point out that in Northern India, where nearly 90 per cent. of the sugar-cane is grown, thin, hard, fibrous varieties generally unsuitable for the economical production of sugar preponderate. It is true that canes in Northern India only contain 9 to 11 per cent. of sucrose (varying with the season)§ while in Java and other sugar-producing countries it is 12 to 13 per cent. and even more. It is also true that the yield per acre is about 40 tons in Java; while in the best sugar growing tracts of the United Provinces the average is about 20, and that elsewhere in Northern India, except the Punjab, it is about 15 tons. But it should be noted that the estimated net cost of cane production in the field, without cutting and carting charges, comes to Rs. 4 to Rs. 5·3 per ton in Java which is not lower than in certain parts of Bihar and Gorakhpur. This is because the cost of manuring cane is

* See p. 27 of NOTES ON SUGAR IN INDIA, by FREDERICK NOEL PATON, 3rd Edition, Calcutta, Superintendent, Government Printing, India

† Since this was written the first sugarcane forecast for 1917-18 has been issued. It shows an increase of 9 per cent. over the acreage for the previous year.

‡ The Director of Statistics with the Government of India informs us that according to the returns received in his Department, the number of sugar factories working in India in 1916 was 28. The annual output of these factories it is difficult to know. Roughly it must be about 100,000 tons.

§ CLARKE, G., AGRICULTURAL JOURNAL OF INDIA, vol. viii., p. 235.

Rs. 35 per acre in Java* and also because the rents there run considerably higher than in the United Provinces. It is true that Java requires only 10 tons of cane for a ton of sugar, while factories in India require about 13·8 tons.† but against this must be placed the ocean freight and import duty that Java sugar has to pay. While we do not deny that the "problem of producing white sugar in India and competing with other countries will be much easier to solve if (1) the out-turn of sugar per unit area is increased by improving and intensifying the cultivation, and (2) if better varieties are selected with reference both to their actual sucrose content and their workability in the factory," we maintain that great cheapness of raw material is not the sole or chief cause of Java's dominating the Indian market. *It is the profitable utilization of the whole of the available produce of the cane by means of factories equipped with the most efficient machinery that gives Java her advantage.* In this connection we quote the following from DR. GEERLIGS' book‡ :—

"The manufacture of sugar from sugar-cane in Java has attained to great perfection and may serve as an example of a well-managed and well-controlled business. The ample investment of funds in the newest machinery, the activity of the sugar experiment stations, the adequate training of sugar chemists and factory chiefs—all these have contributed towards making the Java sugar industry a model one of which it may rightly be proud."

Another difficulty pointed out is the existence of the *gur* industry on account of which the relative profitableness of the conversion of cane juice into *gur* and sugar has to be considered in each tract before any decision can be reached as to the possibility of founding a factory there. Sugar is not an essential food of the majority of the people, who prefer jaggery or *gur*. The *gur* being peculiar to India, its price is unaffected by the fluctuations in the world's sugar markets. It is true that in Java practically the whole of the cane crop is devoted to sugar-making while in India the great bulk is made into *gur* for eating purposes. Now if the producer utilized his produce to the full in *gur*-making and made more profit in this way than by selling the cane to a sugar manufacturer, there would be no reason to complain. But unfortunately it is not so. The wastage in cane-crushing and *gur*-making as carried on by cultivators is enormous; and if this loss is prevented and a slight increase in the yield of cane per acre brought about, India will be more than independent of foreign sugar. It must also be borne in mind that the taste for sugar is growing as the annually expanding imports of sugar before the outbreak of the war showed, while the demand for *gur* is almost stationary or not likely to expand in the same proportion. The abandonment, as the result of foreign competition, of refineries working with old indigenous methods has also added to the amount of cane available for *gur* production. To prevent the *gur* market being glutted and the profits from cane growing being further reduced, it is desirable, nay essential, in the interest of the cultivators themselves to divert a portion of the crop to sugar-making.§ There are well

* See p. 123 of "THE WORLD'S CANE SUGAR INDUSTRY: PAST AND PRESENT," by H. C. PRINSEN GEERLIGS.

† See note at foot of table on p. 277 *infra*.

‡ *Loc cit.*, p. 131.

§ See the article on "The Sugar Industry in the United Provinces," by H. R. C HAILEY—*Report of the Ninth Indian Industrial Conference, 1913.*

defined tracts where factories manufacturing white sugar direct from the cane would be a boon to the cultivators. But where the manufacture of *gur* pays better on account of the superior quality of the product and the high price it commands it comes seriously in the way of white sugar-making by modern factory methods which require large capital and the assistance of many growers. It will obviously not pay to start sugar factories in such areas.

Minute sub-division of the land is also considered a great hindrance in the way of sugar factories in India. For commercial success the factories should naturally be as large as possible. A large block of land is consequently needed, so compact as to reduce the heavy carting charges to a minimum, and the factory should have control over the fields so that it may be kept constantly and evenly supplied with cane. In the settled parts of this country the holdings are small and such sugar-cane as is grown is in scattered plots of small size. We, however, venture to think that these difficulties have been exaggerated. The cultivator, so far from being wedded to *gur*-making, is quite ready to abandon it if he is sure of a good price and a regular market for his cane at the factory. What he usually requires is an advance of some money which the factory owner should try to arrange for as it tends to assist both ryot and factory. In Bihar no difficulty has been found in getting cane, in fact the cultivators prefer to sell their cane and offer more than the factory can work up. It may be argued that this state of things exists in Bihar because the European planter has farmed here for many years, and the people have become accustomed to work with him and grow crops for his factories, hence the planter has a certain amount of control over the crops grown and not infrequently a certain amount of land is attached to the factory which forms a basis for cultivation. But if this is so in Bihar, even in parts of the United Provinces MR. HAILEY thinks there is no reason to regard the difficulties in connection with the supply of cane as insurmountable.*

The fourth obstacle is held to be the competition of crops like paddy, jute, and cotton. Now Madras is capable of growing as good a cane as any place in the tropics, but as the area here is dependent upon irrigation facilities, the crop comes into competition with paddy which is the easiest to grow while sugar-cane is one of the most laborious and difficult. With paddy at present prices and the possibility of growing another crop after it in the year, it is not likely that sugar-cane will, even under favourable circumstances, replace it to any large extent. In Bombay, however, there is no such competition and splendid crops of cane are grown on the canal tracts in the Deccan. The Godavari and Pravara canals and the Nira Right Bank canal when completed will bring about 20,000 acres of new land under cane. In the Central Provinces also, the irrigational developments that are taking place will make considerable areas available for sugar-cane growing. But in both these Provinces it will pay better to manufacture *gur*. In Bengal, low-lying land unsuited for cane is devoted to paddy while the higher land with sufficient water to do without irrigation is fully occupied by jute. Here there is room for considerable improvement both in the direction of cane and palm sugar, but there

* *Loc cit.*, p. 60.

are difficulties as the Province is exposed to the full force of foreign sugar competition on account of its proximity to the sea. In Lower Assam there are large unoccupied areas on both sides of the Brahmaputra which can be utilized for sugar-cane growing. There are special difficulties in the way such as control of surface water, absence of communications, and scarcity of labour which has to be introduced. But these difficulties can be overcome as has been proved at the Government Sugar-cane Experiment Station in Kamrup where heavy crops of cane have been successfully grown. Assam thus offers a good field for large sugar factories. In the United Provinces and Bihar where poppy cultivation has been given up, more land will be put under cane if the relative profitableness of the cane crop is proved to the ryot. In the Punjab* the climate is unsuitable and very poor yields of cane (10 tons per acre) are obtained. In the canal tracts cotton is a serious rival. In the North-West Frontier Province which has 32,000 acres under cane, the district of Peshawar alone commands 24,000 acres and this area is capable of being doubled as the result of the Upper Swat River Canal. Here the growth of beet has been found to be fairly satisfactory.† In addition this district, being far removed from the sea, has some sort of natural protection. A factory, if started here, would be able to work for a sufficiently long season (nearly six months). Burma also offers a prospective field for the fairly extensive cultivation of cane in the Mon canal area.

What then is the principal factor responsible for the moribund state of the Indian Sugar Industry? The reader will have grasped that the most urgent reform required is on the manufacturing side. To indicate the grossly inefficient methods used in the recovery of sugar from cane in India, we give the following table.‡ The figures have been worked out on the assumption that cane is available at Rs. 7 per ton, a working price in North India.

Process.	Tons of cane to a ton of sugar.	Cost of cane per ton of sugar.	Net manufacturing expenses.	Total net cost per ton of sugar.
		Rs.	Rs.	Rs.
Khandsari	27·3	191	70	261
Hadi	20·2	141	56	197
Gur refining	17·4	122	60	182
Small vacuum pan ...	15·0	105	89	194
Modern factory (crushing 300 tons of cane per day of the type installed in Northern India).	13·8§	95	55‖	150

* Even in this Province the official forecast for the year 1917-18 shows an increase of 24 per cent. over the area reported last year. No doubt the high prices of *gur* are responsible for this increase.

† See "Annual Report of the Peshawar Agricultural Station at Tarnab" for the year ending 30th June, 1915.

‡ See p. 15 of the "Note on Indian Sugar Industry and modern Methods of Sugar Manufacture." BULLETIN No. 60 OF THE DEPARTMENT OF AGRICULTURE, BOMBAY.

§ When the crop is poor, with low sucrose content and also low purity, as much as 16 tons of cane are required for a ton of sugar. But when good quality crop is obtained as the result of a favourable season about 12 tons of cane only are required.

‖ The manufacturing expenses are capable of further reduction.—[W.S.]

This table also shows that we can manufacture sugar at a sufficiently low cost in India to compete with foreign sugar if up-to-date factories are set up and a sufficient supply of cane is available at a reasonable rate. As a matter of fact the factory at Pilibhit and the sugar factories in Bihar were running successfully even before the war. As a modern factory requires only half the quantity of cane required by a Khandsari for the manufacture of a ton of sugar, it is obvious that the former can afford to pay better rates than the latter. The introduction of these factories with proper organization and efficient management will therefore be a boon in those parts where sugar manufacture is relatively more profitable than *gur*-making. At present we import 61 lakhs of rupees worth of molasses—the by-product of sugar factories—and large quantities of molassecuite which is a cattle food prepared from molasses. If more sugar factories are opened in India they will be able to meet this demand and a license to manufacture rum will not be essential if steps are taken to further develop the use of these by-products within the country itself.

It is necessary to ascertain the number and locality of suitable sites available for modern sugar factories in India. MR. NOEL-PATON* has given a list showing total area, area under sugar-cane, neighbouring large towns, population, etc., of each district in India. This information requires to be supplemented in the following way. A list of places where cane cultivation occupies in any single year about 3,000 acres within a radius of 5 miles or at such distance as can be commanded within 48 hours of harvesting should be prepared for the guidance of those who wished to set up central sugar factories capable of crushing at least 300 tons of cane a day. For this a special Government enquiry is absolutely necessary. Unless we can get and place reliable figures regarding the acreage under cane available in any locality or place, no capitalist will be attracted to the industry. What is therefore required is encouragement on the part of Government for capitalists to come forward. How did the Japanese Government promote the sugar industry in Formosa? We are not admirers of Japanese methods in that island, but the effective measures they took for creating a sugar industry on modern lines are pretty instructive. Why not institute a Government department giving facilities to sugar companies for the erection of modern factories and at the same time multiply sugar experiment stations for testing and introducing better varieties of cane and improvements in cultivation. If we adopt a vigorous policy of encouraging the formation of sugar companies, by subscribing for some shares or guaranteeing interest for a certain number of years, and provide a body of highly qualified officers who would go round and instruct the factory managers regarding the best type of machinery to be installed, the chemical control of the factories, the most profitable utilization of the by-products, checking waste, etc., we shall soon see a large number of factories springing up in India and a healthy industry in progress. Perhaps the question may be raised how Government is to meet the cost. We suggest that for the next ten years the import duty

* See the chapter on Openings for the Industry in his NOTES ON SUGAR IN INDIA.

on sugar should be raised to 15 per cent. for Mauritius and other British Colonies, 20 per cent. for Java and other allied or neutral countries, and 25 per cent. for Germany and Austria. The proceeds will be over a crore of rupees and some portion of this money can be legitimately used for the fostering of the Indian white sugar industry.

Let us for a moment consider what it will mean to India if she comes into line with other sugar producing countries by the adoption of improved up-to-date methods. Over 12 crores of rupees would remain in the country, cane cultivation would become more profitable and thereby make the cultivators more responsive to new ideas such as the trial of improved varieties, heavier applications of manure, and better tillage. The basis of Indian agriculture would be widened and firmly established by the rehabilitation of one of her staples. Her general economic condition would be materially improved by the substitution of a substantial and sound industry for a steadily declining one.

We now turn to the question of the *gur* industry. Even here there is great room for improvement. To those who know how many industries in the world now carry on solely by the successful utilization of by-products and careful economizing at all points, it is heart-rending to see the waste that is going on in this particular industry in India. The cultivator works hard for periods varying from 10 to 18 months, sinks a lot of capital (having regard to his means), raises a successful crop with the limitations under which he has to work, e.g., imperfect implements, inadequate supply of manure, etc., and yet because he does not know or because he has no means he fails to recover even a decent average amount of sugar from his crop, in fact reduces the possible output by 35 to 50 per cent. and suffers in consequence. Could we but teach him that he wastes 20 per cent. of the sucrose when crushing his cane by a bullock-driven mill and that all told a loss of nearly 35 to 50 per cent. occurs in the whole process from the time the cane is cut to the complete manufacture of raw sugar, he would soon realize why it is that cane cultivation does not pay him as it ought to. The main point is that even with the existing varieties and the present low yields of cane per acre it is possible to make the industry more remunerative to the cultivator, to increase the supply of *gur* and make more raw sugar available in this country for refining, and thus indirectly to reduce her imports of foreign sugar.

Let us look more closely into the actual milling as done by the cultivator. With the ordinary 3-roller mill driven by bullocks, in the case of a cane having 8 per cent. fibre, and a total possible juice production of 89·3 per 100 of cane, the cultivator will extract *even under the most favourable circumstances* only 74·9 per cent. of juice ; while a Krajewski cane crusher and 3-roller mills with maceration will extract 86·9 per cent. of juice. When the fibre content of cane is 15, the best 3-roller bullock mill will only extract 53 per cent. juice, while with the Krajewski cane crusher and 3-roller mills with maceration the extraction runs as high as 75·5 per cent. out of a possible 80.* That is to say, where the fibre content is high the cultivator

* See table on p. 12 of "Muscovado Sugar Machinery and its Scope for *Gur* Manufacture in India." *Bulletin No. 52 of the Department of Agriculture of Bombay.*

stands to lose much more with his present methods of crushing than in the case of canes with a low fibre content. It can be safely said that there is a loss of upwards of 20 per cent. of sugar with the methods of extraction now at the disposal of the farmer.* As a matter of fact we know that on account of the strain on the bullocks the mills are often slacked off and their efficiency consequently suffers still further. But just imagine what country or what industry could or would stand a waste of 20 per cent. occurring in a single operation which is but a link in the whole chain of the process of manufacture if it had any competition to meet. How can the cultivator find the crop a paying one nowadays when imported sugar manufacture with all the latest mechanical and chemical improvements is cheaper than the indigenous product? It was all very well in the days when there was no competition from the outside world; then the consumer had to pay a heavy price for the inefficiency of the cultivator as a manufacturer of sugar. But that is all changed now. The outstanding fact is that steam power must be employed for crushing cane whenever we can get a sufficient area for the smallest steam plant to run economically. Bullock power cannot successfully compete with it. In the case of cane there is an additional advantage in favour of steam power because the refuse of the cane, i.e., bagasse serve as a fuel. Power crushing means quicker, cheaper, and more efficient crushing. Oil engines solely used for this purpose are handicapped for the following reason. Steam plant for sugar factories is so devised as to run on bagasse alone and no extra fuel is required, whereas in the case of oil engines the cost of oil is a most substantial item. The losses that take place in boiling the juice are equally serious. This is only to be expected when we take into consideration the crude appliances at the disposal of the farmer and his natural lack of knowledge of the chemical processes involved in sugar boiling. The late MR. BARNES† has stated that in Gurdaspur nearly one half (varying from 34 per cent to 57 per cent) of the sucrose in cane is lost in the whole chain of operations from milling to boiling. At present the juice is boiled in open pans direct over the fire. The heating surface thus provided is not large and the result is that a part of the crystallizable sugar is lost in inversion and caramelisation. If steam power is used it suffices both for motive power and for evaporation. In steam evaporation a large heating surface is provided and the losses due to inversion proportionately reduced. Steam heating is also more efficient than open fire heating. In modern sugar factories heat is economized by the use of "multiple effect" evaporators and vacuum pans. At present cultivators in India increase the manufacturing expenses by burning extra fuel whereas with the help of evaporators and vacuum pans in a *gur* factory they ought to be able to run with megasse alone particularly where the cane is very fibrous. The burning of sugar-cane trash which is so common in some parts of India is equally wasteful; it can be utilized very profitably as manure. To get the full advantage of steam power we must resort to multiple crushing; to evaporate the juice with the expenditure of

* See "Sugar and the Sugar-cane in the Gurdaspur District," By the late MRS. J. H. BARNES. *Bulletin No. 69 of the Agricultural Research Institute, Pusa.*

† Loc. cit.

minimum heat energy and to obtain a better quality of produce we must resort to multiple evaporators. We condemn the open fire system because it leads to an increase in the glucose ratio, making the *gur* soft and sticky and liable to run in damp weather. Such *gur* provides very unsuitable raw material for refining. Under steam evaporation the increase in the glucose ratio is not as great and hence better quality *gur* is produced to the great advantage of the refiner. From every 100 maunds of *gur* as prepared by the country method a refiner is lucky to get 55 maunds of sugar, whereas from the same quantity of *gur* evaporated by steam he will be able to recover 10 to 15 per cent. more.* It may be argued that crushing his own cane is a case of "Hobson's choice" on the part of the cultivator. But it is surely to the advantage of the community, as a whole for the State to come forward and show the cultivator how best the crushing can be done, put up efficient installations at some centres, charge reasonable rates for crushing and manufacture of *gur*, and thereby conclusively prove (by the only method possible) to the cultivators that these modern methods of crushing and boiling are very profitable. Once these are being successfully worked and the cultivators convinced of their superiority the promotion of steam factories for *gur* can be encouraged. In order to ensure the successful working of the factory the cane growers should be given some interest in it and the local *soukars* should be persuaded to take shares in it, or if this is not possible a Government officer, preferably of the agricultural department, should fix the price at which cane should be supplied to the factory so that it may be remunerative to both sides; arrangements would be made by the factory for financing the cultivators so that they may not have to go to *banias*, but should look to the factory naturally for finance on easy terms. In Formosa the Sugar Bureau requires each mill to submit to it the scale of prices which it proposes to pay for the canes within its district, the object in view being that the farmers should get a fair rate. It is still open to question how far this Bureau has discharged its obligations towards farmers, but the principle is sound, and might, if worked equitably, do much good in this country. We are sure that under safeguards like these there will be no difficulty in running a factory. If the cultivator can get as much by selling cane direct as from *gur* manufacture, he will soon see the advantage and confine himself to his legitimate work of raising the crop and then selling it to those who manufacture it best. We mean to make it clear that even *gur* manufacture should no longer remain a cottage industry. Either the cultivators themselves should combine and work a *gur* factory, which I do not consider is within the range of practical politics at present, or else some other agency with proper safeguards should undertake the job. While several thousands of acres are required for a central factory, a few hundreds of acres will suffice for a *gur* factory. Experts are of opinion that such a factory can work successfully if a minimum of 5,000 tons of cane is available within a radius of 4 miles.†

* See Bombay Department of Agriculture Bulletin *No. 52*, for a fuller account of the advantages resulting from the use of steam power for crushing and evaporation.

† The factory will pay best if it crushes 100 tons of cane per day or 10,000 tons in the whole working season. A correspondingly increased area under cane will in that case be required. [W.S.]

This would postulate an area of some 250 acres actually under cane in any single year in the Deccan and Madras, while in Northern India some 400 acres will be required. An enquiry should be set on foot to find out the likely sites for the erection of *gur* factories and these should be published for the information of capitalists.

At this stage the question will naturally occur to the interested inquirer what should be done where cane cultivation is so restricted and scattered as not to come within the scope of central sugar factories or even *gur* factories. The answer is that in such parts the cultivators must adopt such cultural and other improvements as the Agricultural Department suggests; otherwise they will find the crop more and more unremunerative in future and will ultimately be obliged to give it up altogether, if there are no special causes favouring the crop in these localities.

We will now briefly refer to the sugar refining industry. It will be best if in parts like the Deccan the factory works as a combined one for the production of *gur* and refining sugar. This will present no difficulty. In the off season it can refine inferior *gur* or imported raw sugar, this will not materially increase the cost of the factory, because for refining we only need to add a blow-up tank and a bag filter. Thus when *gur* is dearer than sugar the factory can manufacture *gur*, but when this stuff is cheap it can do the refining work. In this connection we venture to think that a revision of the sugar tariff appears necessary.*

In India there is at present an *ad valorem* duty of 10 per cent. on all imported sugar irrespective of the fact whether the sugar is white or semi-white raw sugar (grey crystals) 15 D. S. and under. Now we venture to think that it is not economically sound to go on importing refined white sugar when we can import the latter and refine it here. There is always a difference in the price of these two classes of sugar which corresponds to the cost of refining. Now in order to enable the local refinery to work at a profit differential rates of duty should be levied on these two classes of sugar. In Great Britain before the war the duty was 1*s.* 10*d.* per cwt. of white sugar while it was only 10*d.* per cwt. of raw sugar. The difference of 1*s.* per cwt. represents the refiner's profit. The *ad valorem* duty in India does not leave sufficient profit for the refiner. This is clear from the following table:—

	Price per cwt.				10 per cent. duty.		
	Rs.	A.	P.		Rs.	A.	P.
Sugar, crystallized and soft, from Java 16 to 22 D. S. ...	14	8.	0	...	1	7.	2½
Sugar, crystallized and soft, from Java, 15 D. S. and under ...	12	0.	0	...	1	3.	2½

* See "Indian Sugar Tariffs and the Indian Sugar Refining Industry," *Report of the Ninth Indian Industrial Conference, 1913.*

The difference of 4 annas per cwt. is not sufficient for a refiner, being only one-third of what it is in Great Britain. The duty should be made *specific*, say Rs. 2 per cwt. for white sugar of 16 D.S. and above, and only Re. 1 per cwt. for sugar of 15. D.S. and below. This will enable several refineries to be put up in these parts (Calcutta, Madras, Bombay) which on account of their proximity to the sea have felt the force of foreign sugar competition the most. The profits of a refinery being steady, it will give a great impetus to the Indian sugar industry. Before the war we used to import about 500,000 tons of white sugar (16 D.S. and above) per year. This shows that there is wide scope for refineries in India to work successfully, provided a revision of tariffs is carried out. It will be argued that this will transfer to the pockets of the refiners the money which should go to Government. To this we reply that the money will at least not go to Java and other countries. It will create a local refining industry while it will in no way increase the price of the commodity to the consumer. Government will also not suffer any loss in revenue if the scale of tariffs is so adjusted as to realize the whole or a major portion of the required revenue from the duty levied on raw sugar, the importation of the refined product being discouraged by the imposition of a higher duty.

To sum up. It has been made clear that the problem of the Indian Sugar Industry is a two-fold one, and energetic measures should now be set on foot to place both the *gur* and the white sugar industries on a satisfactory working basis; to do this properly will require a survey to be made of the localities where white sugar factories can be erected and at the same time the districts where the cane cultivation is only capable of carrying a *gur* factory should be carefully recorded. The financial side of the matter and the question of State assistance to the pioneer factories also require to be carefully examined. To do this will require a strong committee of experts who will also be able to report to Government how far the manufacture of sugar on a considerable scale, together with its by-product—alcohol—can be made the subject of excise control in India. The question of the creation of a special sugar department for India for tackling and co-ordinating the numerous manufacturing, agricultural, botanical, and chemical problems connected with the industry could also be dealt with, but the main question is to get it dealt with at once, for, at present, Indian sugar is being made under most favourable conditions, and this state of things, which gives an insight into the possibilities of the industry in India, when foreign competition is lacking or curtailed, will not last for long, and if the industry which is now in places getting its head above water is allowed to be stifled again by unfair competition it will not readily respond to efforts made in the future to resuscitate it.—AGRIC. JOURNAL OF INDIA, VOL. xxi, PT. iv.

SUGAR IN INDIA.

Sugar and sugar-cane have of late attracted a good deal of attention in India, says the *Times of India* "Trade Supplement." The industry has been hit hard by the imports of Java sugar which have increased in 25 years from 70,000 to over 800,000 tons. This has led to a considerable diminution of area in certain provinces. The statistics of production and imports clearly show that although India is the greatest producer of cane sugar (raw) in the world, she cannot meet her own demands. The problem, therefore, has been how to make her self-supporting and this is what the Agricultural Departments are attempting to investigate so far as the cultivation of this crop is concerned. The prevailing high prices of sugar have given a boom to the cultivation and the area in 1915-16 was 2,373,000 acres. On the manufacturing side a good deal has been done in the spread of improved methods of gur-making, economical furnaces and more efficient crushers. The plant designed by MR. HULME for dealing with both sugar and gur (uncrystallised sugar) on the smallest commercial scale, requires further trials before any definite opinion can be pronounced on it. The sugar factories in Bihar had a successful working season last year owing to the high price of sugar, although the yield of sugar from cane was not satisfactory owing to drought. The placing of 10 per cent. customs duty on imported sugar without any countervailing excise duty is a form of State aid which should help the establishment of central factories in suitable parts of India. The establishment of central factories is likely to be successful in the south-eastern parts of the United Provinces, e.g., the Gorakpore Division, and in Bihar and Assam. In other parts the price of gur being high and the cultivation of cane being scattered, there seems to be little likelihood of such factories being established on a paying basis.—MYSORE ECONOMIC JOURNAL, VOL. III, No. 7.

JAMAICA GOVERNMENT-AIDED CENTRAL SUGAR FACTORIES.

The Jamaican Government—or perhaps it would be more accurate to say the Colonial Office—are now fully persuaded of the wisdom of State aid for establishing sugar centrals in Jamaica, so as to augment considerably the sugar output of that largest of our West Indian possessions. SIR FRANCIS WATTS, K.C.M.G., has been touring the island lately and meeting the sugar planters of the various parishes with a view to ascertaining the possibilities; he has already prepared a scheme for the establishment of Government-aided central sugar factories, and the Legislative Council are being asked to give effect to the proposal. The proposed agreement provides that the cane growers of a given district shall combine amongst themselves under contract to cultivate a sufficient acreage in canes to keep a sugar central in their neighbourhood employed, and shall form a company, the shares of which will be assigned to the Government to be held by the latter as security for the Government interest in the factory, and that on this being done, the Government will advance to the company a sum agreed upon for the erection and working of the factory. The factories schemed for by SIR FRANCIS WATTS would have capacities of from 5,000 to 10,000 tons.—INTERNATIONAL SUGAR JOURNAL, JUNE 1917.

ENTOMOLOGY.

THE HISTORY AND PRESENT POSITION OF WHITE ANT TREATMENT IN MALAYA.*

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On considering what subject to select, of interest to both the rubber and coconut sections of the planting community, I thought it might not be unprofitable to traverse the history of the treatment of the major pest of plantation cultivation in Malaya, namely *Termes gestroi*, to endeavour to trace the development of knowledge of the pest and of efforts made to combat it, to see, if possible, where the earlier workers went wrong, and perhaps to extract some lesson applicable to the present.

It is probable that there are some here of long experience of Malaya, and of long memory, who would be better able to discuss the historical side than I. For the earlier material I have to depend largely upon the AGRICULTURAL BULLETIN of the Straits and Federated Malay States edited by RIDLEY. Of the last three years, during which considerable advances towards the complete control of *Termes gestroi* have been made, I venture to think I need make no apology for drawing upon my own experience.

FIRST RECORD OF DAMAGE BY WHITE ANTS.

The first printed record of white ants damaging crops is in an article by RIDLEY in the AGRICULTURAL BULLETIN of the Malay Peninsula No. 4, January, 1895. He wrote: "One constantly hears of coffee and other trees being destroyed by termites, and the informants seem to think that the insects absolutely eat the roots and base of the stem of the living tree, and so destroy it. I have great doubts of this." RIDLEY's doubts were based upon several observations. He instanced that on opening termite nests, by which he presumably meant mounds or nests in the soil, undamaged roots of plants might be found traversing the nest. He described how termites "usually so induced by a dead bough" throw up galleries along the trunk and attack the bark, and so "by letting the wood suffer from exposure, injure or kill the tree." "But this," he wrote, "is rare and almost invariably occurs in trees dying from other causes." A young clove tree, the death of which was at first ascribed to termites because galleries were thrown up around the base of the tree under which the insects had eaten away all the bark, was subsequently found to have been attacked by a fungus. "As soon as the fungus had practically killed it the termites threw up their galleries and began to destroy the dead part of the tree." Similarly

*Paper read before the Agricultural Conference, Malaya, 1917.

with two young Araucarias, the primary cause of death being starvation through root competition, with a contributing mechanical cause in the compact clay masses of white ant nests beneath the trees. RIDLEY then generalized as follows: "Such action is what appears to be generally intended when it is said that a tree is killed by termites, the real cause, being perhaps obscure, is overlooked, and the termites who come to remove the dead tissue are credited with the original injury."

From this article it appears that the typical *Termes gestroi* habit of attacking live trees was not then known. It follows that in 1895 the insect was not a pest of major importance or such a sound observer as RIDLEY could not have failed to have noted this fact.

It is unlikely that any of the termites observed by RIDLEY in Singapore up to this time was *Termes gestroi*, and he was probably quite correct in ascribing these particular attacks to diseased conditions. But I think it very likely that his generalization based upon observations of other species was subsequently taken by planters to apply to *Termes gestroi*, and developed into the pernicious idea that the trees lost through white ants would have died anyway, or at best would have been of little use. This fallacious theory of pre-disease has continued almost, if not quite, down to the present.

In 1897, the Linnean Society published HAVILAND's "Observations on Termites, with descriptions of New Species." This is the standard scientific work on Malayan termites. Twenty species, including *Termes gestroi*, were described from British Malaya and a further considerable number from the Islands, but they were not treated from the economic side. *Termes gestroi*, however, received considerable attention because "the species is one which deliberately attacks and destroys live trees." The soldier, upon which classification is based, was described in detail, and shorter descriptions given of the workers and nymphs—that is, the winged individuals which develop into kings and queens. Unfortunately, HAVILAND did not obtain the adult king or queen, and from his failure to find them came to the conclusion that "the same colony often possesses several nests, only one of which is inhabited by fertile individuals whose eggs and young are carried to the other nests." My own experience does not bear out the whole of this. Subsidiary nests are made by *Termes gestroi* in its feeding places but I have never seen eggs in these. Always the parent nest alone contains the eggs, and every nest containing eggs contains also the queen. Of the habits of *Termes gestroi*, HAVILAND wrote: "The species is remarkable for its habit of killing live trees. It encases the trunk for a distance of eight feet from the ground, with a thick crust of earth. Under cover of this crust it eats through weak spots in the tree to the heart of the wood, which it excavates, forming there a kind of nest built of wood fibre."

Next in chronological order is a further article by RIDLEY in May, 1900. A brief description of the soldier is followed by an account of the attack

upon trees which is almost identical with HAVILAND's account, stating, as he did, that the nest is formed of wood fibre inside the attacked tree.

That *Termes gestroi* was increasing in importance as a pest is evident from RIDLEY's comments upon the failure of treatment, consisting of scraping down the mud casings and treating the injured surfaces with tar or substances injurious to the insects. RIDLEY also observed that he had received from SELANGER "Specimens found destroying Para rubber trees."

It should be noted that both HAVILAND and RIDLEY say nothing of the whereabouts of the source of the attack—that is, the parent nest. The subsidiary nests described are obviously one of the sequelæ of the attack.

It is a great pity that the nesting habits of *Termes gestroi* were not then determined as valuable years were lost before more definite knowledge was published and applied. Had planters then known where the parent nests were to be found, and how successfully the pest could be treated through these, *Termes gestroi*, might never have been given the opportunity to multiply and establish itself as a pest of such enormous importance.

Nowhere is the copy book maxim "prevention is better than cure" more truly applicable than in the province of economic entomology and to no insect more aptly than to *Termes gestroi*. But for either it is essential to have an accurate and full knowledge of the habits and life history of the insect; efforts at both prevention and cure were shortly made, but without the essential knowledge they were foredoomed to failure.

LACK OF INFORMATION ABOUT *TERMES GESTROI*.

The unfortunate lack of information about *Termes gestroi* in the early days is in my opinion one of the gravest misfortunes suffered by the Malayan Para Rubber Industry, not alone, or mainly, because thousands of dollars were wasted, and trees lost, but because fuller knowledge would have induced the employment of sound measures of timber treatment, and clean clearing, with all its accruing advantages might have become as much a *sine qua non* of rubber cultivation as clean weeding.

The next two publications threw little further light on the subject. In October, 1901, W. W. BAILEY contributed a report in which he describes "Termites" as the worst enemy of his rubber, eating out the heart of his healthiest and best rubber trees. Having tried arsenic, sulphate of copper, phenyl, tuba, kerosene oil, etc., without success, he decided to set coolies on to digging out queens and breaking up the mounds, although he says he had been told by more than one scientist that the queen of the rubber termite was not to be found in mounds. The queens were taken from mounds one to two feet high and each man averaged ten a day. "It may be said," he wrote: "That they are not termites, and it may be true; but one thing I am certain of, and that is that they are identical with the creature that is destroying our rubber trees . . . I feel certain that I shall almost exterminate these insects on my estates."

In the light of present knowledge it is obvious that to whatever else species the queens belonged which were dug out of the mounds, they were not *Termes gestroi*, and that not by this method was there any hope of protecting the rubber trees.

In November, 1901, RIDLEY, writing upon a recent visit to Selangor, expressed his admiration of the splendid coffee and Para rubber trees he saw, but "the drawback was the white ant pest, and it was truly grievous to see fine four-year old Para rubber trees killed by their attacks." Suspecting fungus disease in addition to termites, several trees were pulled up and their roots examined. On one a fungus was found and identified as *Helicobasidium* sp. RIDLEY observed "I am aware I am on debatable ground as to whether the particular tree I examined which had fungus at its roots was killed by that fungus or by white ants or by both . . . My own theory is that in this particular instance the fungus was the cause."

In a letter from Lanadron in December, 1901, FRANCIS PEARS wrote: "The age of my trees is from 2¾ years downwards and as yet I have not had a single established plant destroyed by white ants, although certain portions of the estate contain numerous ant heaps such as MR. BAILEY describes; on one ten-acre block as many as two hundred. This, Sir, may slightly bear out your theory that a fungus is principally instrumental in destroying the trees in Selangor."

I believe I am correct in saying that Lanadron was clean cleared of timber before planting. What an epoch-making letter that would have been if PEARS had deduced the true reason of his freedom from white ant attack, that the absence of timber precluded the possibility of attack by *Termes gestroi*.

E. V. CAREY in March, 1902, gave what should have been the death-blow to the system of destroying queens from mounds. He described how, having in the pre-rubber days paid out considerable sums in rewards for queens because *Termes gestroi* was attacking the coffee, he submitted some specimens to E. E. GREEN in Ceylon, who, of course, told him that he was catching the wrong species. Later, when Para, rambong and coconut were attacked "roots were bared and kept open to the air, painted with tar, washed with Bordeaux mixture, solution of tuba root, sweet flag, Jeyes disinfectant, etc." without success. Then BAILEY of Lowlands tried another method which had met with such "unqualified success" that CAREY ascribed to him the credit "of having put us all on the right track." The method was a thorough digging over of the whole attacked area. CAREY recommended a modification, contenting himself with digging from attacked trees, 2½ to 3 feet deep for a distance of not less than 10 feet in every direction, and further following the runaways up to the nest and destroying the queen. Even if the nest were not found, the disorganization of the runaways was held to be sufficient to prevent the termites returning to the same tree a second time.

It could not be long before this method discovered its weakness. The only effect upon the attack would be to drive it to fresh trees. Moreover, many attacked trees would go untreated because, as ROBINSON was soon to point out, in a considerable percentage of cases there are no external signs of damage.

By far the most important thing in this article of CAREY'S is the following note in parenthesis: the nest "is almost always found in a log or the stump of an old tree." It is amazing to me that not until another six years had elapsed was this knowledge applied by treating timber, and that a further six years was allowed to pass before clean clearing as the only perfect treatment for *Termes gestroi* was seriously supported by any of the men engaged in agricultural research in this country.

FIRST STEP TO INVESTIGATE PEST.

The first serious attempt to investigate the pest was made by ROBINSON now Director of Museums, whose account is published in the *Bulletin* in December, 1904. I can do little more than indicate some of the more important features, and recommend you to re-read the whole for yourselves. A simple key to the species commonly found on estates is followed by a good account of the nests of the mound-building species. The useful part played by these species in converting timber into available plant food is pointed out and the futility of treating them insisted upon.

Termes gestroi, ROBINSON remarked to be rare in nature, and ascribed its abundance on estates to the stimulus provided by unusual quantities of suitable food in the form of rubber trees. The first detailed account is given of the external attack under cover of the mud casing, under which, sooner or later, a non-resistant spot in the bark is reached, through which "the whole body of termites gains access to the interior of the tree which is rapidly eaten out." ROBINSON also was the first to point out that a large percentage of attacks is made below the soil level, no external signs of damage showing. He opposed the theory of antecedent disease, but pointed out the likelihood of *Termes gestroi* effecting entrance through wounds. The remedies of the time are discussed and dismissed as failures with the exception of powdering the collar and roots thickly with freshly slaked lime after scraping off the incrustation. For the treatment of internally attacked trees an ingenious application of CS_2 vapour is suggested. But there is not a word about destroying the nesting sites. ROBINSON wrote: "The nests are contained within the trunks of the trees attacked, and are formed of narrow labyrinthine chambers of woody and earthy matter . . . the whole of the interior of the tree being more or less filled up with this material." Now, this is typical of the subsidiary nests made in live trees where *Termes gestroi* is feeding, and it is probably such nests that ROBINSON explored and described. ROBINSON found one nest out of many investigated which contained eggs—that is, a parent colony. Personally, I have never found a parent nest in live rubber, although such do occasionally occur in old rubber where surface timber has gradually rotted away. Always the parent nest has been in a log or stump. One might search long in attacked young rubber

trees for a parent colony without success, but if such were found it would only serve further to obscure the general truth. CAREY's clue of the logs and stumps was not followed up, and this otherwise valuable report is marred by the failure to provide that most desirable of all information, the location of the main nest.

In April, 1906, E. P. STEBBING, Forest Zoologist in India, entered the discussion because of specimens sent from Mergui Estate. STEBBING, who of course, had no first-hand knowledge of living *Termes gestroi*, urged the need for procuring full information upon its life history. Among points which he indicated as requiring elucidation, there are two of vital importance —namely, "Where do the termites found in the nest in the crown of the root come from in the first instance?" and "Are there any galleries radiating from the nest to other parts of the plantation? If so, where do they go?" Now this is the first consideration of the problem by a trained Economic Entomologist, and it is interesting to note that at once the true line of investigation was suggested.

In May, 1908, PRATT supplied the material for answering STEBBING's questions in an interim report upon his termite work. Tracing back runaways from 15 or 20 eight-year old rubber trees, all of them terminated in a nest, about two feet in diameter, constructed round a buried stump. In this nest was discovered the first authentic queen. Runaways ramified from the main nests, broadening out in places to form large open spaces from which branch burrows diverged, the larger of these leading to subsidiary nests inside stumps, logs, and fallen trees. This was indeed an important verification of CAREY's statement, and laid the foundation of a rational method of treatment. PRATT pointed out that the age of the rubber, and the nature of the soil had little, if any, effect upon the incidence of the attack, but who really mattered was the presence of timber. The supposed deadly effect of lalang upon *Termes gestroi*, he rightly ascribed to the general absence of timber on old lalang areas. Further promise of being on the right track at last was given in the following passages: "The most important point in connection with the present abundance of *Termes gestroi* . . . is that it attacks dead as well as living wood . . . The fact that it is among the dead wood, and rapidly multiplying has been ignored. It is only when the rubber trees are being attacked that any measures are taken against its ravages." PRATT then pointed out how useless it was to treat individual trees while there was a constant supply of termites from the nest-log or stump.

Unpublished correspondence of about this date shows that one estate, on old lalang land, had never been troubled by *Termes gestroi*. The inference would appear obvious from the presence of *Termes gestroi* in timber and its complete absence in timber-free land, that clean clearing was the soundest treatment for the pest. Whether this inference was made, and dismissed as impracticable for reasons of expense, there is nothing to tell us. Instead PRATT recommended as "preventive measures" the piecemeal method of tracking down the nest by following runaways from attacked trees, and a

selective method of dealing with timber. Among native timbers known to harbour *Termes gestroi*, kumpas, meranti and pulai were given the place of honour. It was recommended that these should not be destroyed at first, as "they subsequently afford means of locating *Termes gestroi*," and should then be destroyed with the termites.

Now these methods predicate, before treatment, the establishment of colonies in the timber, and probably serious attacks upon the rubber trees. Surely this is not preventive treatment. Treatment after attack may result in eradication, but preventive measures should leave nothing to eradicate.

PREVENTIVE MEASURES.

To TOWGOOD, in March, 1909, belongs the credit of first advocating the preventive destruction of all nesting places.

After pointing out that white ant timbers varied with locality, he went on to describe methods applied successfully by himself. In old rubber these consisted of collecting and destroying all surface timber, and if then there were further attack, to follow the runaways down to its source, which was invariably in a buried log or stump, and to burn the whole nest.

One field of six years old Rambong was interplanted with Hevea, and white ant attack on both was particularly virulent. Five months before writing TOWGOOD had cleared the field of all timber, and no sign of the pest had since been seen.

In many young clearings, the timber suitable to *Termes gestroi* were sought for line by line, sawn through, and burnt if the pest was present.

For future clearings, TOWGOOD recommended felling the favourite white ant trees first, and allowing them to dry prior to felling and burning the rest of the jungle. In this way he hoped to prevent *Termes gestroi* ever getting established.

Now these are all much sounder methods, but naturally they entail greater immediate capital expenditure. Against this TOWGOOD pointed out that in addition to the satisfaction of knowing that the only troubles they feared—namely, white ants and *Fomes*, were eradicated, there would be less subsequent expenditure in pest work, supervision would be more efficient, weeding costs less, and all work carried out in the clearing would be cheaper.

TOWGOOD, then, advocated clean clearing old rubber, destroying trees which contain *Termes gestroi* in young rubber, and selective burning in future opening. The first was sound. The others were dangerously incomplete even against *Termes gestroi* alone, not to mention *Fomes* and the later discovered root disease, *Sphærostilbe*, *Ustulina*, and *Poria*, because any remaining suitable timber in the young rubber might later become infected by *Termes gestroi*, and in the new clearings there is a much greater variety of potential *gestroi* timbers than TOWGOOD suspected. A letter from Johore in December, 1909, lists a further 19 timbers harbouring *Termes gestroi*, Terentang heading the list with over a hundred nests in 40 acres, but the other 18 equally capable of serving as a nidus for *Termes gestroi*, if the favourite timber is absent. The only sure guarantee against *Termes gestroi* attack is to remove, not only every certain, but every possible nesting site. Nevertheless, TOWGOOD was on the right track, and had his advice been followed improvements in details would have developed.

But just now the sulphur arsenic fumigator was being boomed as a cheap and effective method of treatment. Everybody was wanting a remedy easy of application, certain of result. A prize of £5,000 was offered to the inventor of such. It was not awarded, but public attention was focussed on patent methods, and the universal exterminator was certainly the best of these. And so, unfortunately for those estates now suffering from the many ills bred of rotting timber, clean clearing was set back a further six years.

In October, 1908, PRATT was transferred from the Medical to the Agricultural Department, and devoted some time to the continuation of his white ant work. You are all familiar with the results as published in *Bulletins*, Nos. 1 and 3, of the Department of Agriculture. The first was largely a revision of the report previously considered. *Bulletin* No. 3, which deals mainly with treatment, is too long for me to discuss in detail.

In blocks in which the jungle had been felled less than six years, PRATT advocated isolating attacked areas by a four-foot drain, digging over the soil to a depth of three feet, and burning all the logs and stumps containing *Termes gestroi*. He did not recommend destroying all logs and stumps but said that the proportion which needed removal was comparatively small. As an alternative method, equally effective and cheaper, to be used whenever possible, he strongly recommended fumigation with sulphur-arsenic fumes. The nests having been located, presumably by inspection, a trench was to be cut round it, left open for a few days to allow repair of the runaways, and then nest, runaways and attacked trees were to be thoroughly fumigated. "If a little care and interest are taken" he wrote, "and the treatment carried out as it should be, not only would the cost be very small, but the trees within this area will not again be troubled by *gestroi*."

In older clearings, originally planted with rubber, PRATT considered that in all except peaty soils, most of the timber would have become too rotten to harbour *Termes gestroi* and the nests would have been transferred to the rubber trees. All trees suspected of being hollow were to be bored and fumigated, and any remaining hardwood logs which contained nests were to be destroyed.

In peaty soils, which frequently contain much buried timber and roots, fumigation was to be used wherever possible; if it were not successful recourse must be had to the isolating drain and deep changkolling. Thus was the fumigator given official benediction as the premier method against white ants, and clean clearing relegated to the background with scarce even a nod of recognition.

This bulletin concludes with an exhortation to planters not to be unduly alarmed for the future, inasmuch as, although it is wise and profitable to treat the pest, "there must inevitably result a steady diminution of *gestroi*, among the older rubber," except on peaty soils. Such a disparagement of the danger would in itself have been enough to deter planters from recommending expenditure on clean clearing.

FUMIGATION.

From this time onwards more and more reliance was placed in fumigating, generally with incomplete results. Those planters who tired of the fumigator, usually fell back upon local applications of poisons, with worse results. The pro-fumigants held that lack of success was due to inefficient application of the method, and that with trained gangs and competent supervision all would be well. Late in 1914, I had my first experience of white ant work, and went about an enthusiastic exponent of the fumigating school, but before the middle of 1915 I was satisfied that fumigating, although the best of the palliatives, was at best but a palliative. Perfectly applied by perfect coolies, it might keep the attack down to a minimum, but who possesses the perfect coolies? Was there not some other more effective remedy to be deduced from our fuller knowledge of the life history of the insect?

In nature, under jungle conditions, *Termes gestroi* is a rare insect as compared with many other local termites. It is established in certain dead or dying trees. At certain times there is a flight of sexed individuals from the nest, any pair of which can found a new colony, provided suitable conditions—namely, shelter and dead wood. In the jungle such suitable conditions are seldom met but on a clearing with quantities of unburnt wood suitable nest sites are abundant, and even if one favourite type of timber is absent, another can be made to serve. Hence from one mature colony, inside or just outside a clearing, a considerable percentage of the logs and stumps may be infected. Allow one or two years of undisturbed development, and you have numbers of colonies at great strength, ready to attack rubber or any other suitable material, or to spread the infection by swarms of flying individuals to uninfected areas or logs. Trenching, digging, poisoning, fumigating, tracing runaways, and numerous modifications and combinations of these had been tried and found incapable of eradicating the pest. Deep changkolling over attacked areas had been abandoned—if it was ever tried—probably because of the cost. In some places the surface timber was being hunted through for nests, the logs cut open and the queen sought and killed. As it had been frequently stated that *Termes gestroi* had not the power possessed by a lot of species of elevating baby commoners to the position of temporary queen, this looked likely at least to stop any further development of these nests. But this method had soon to be discarded also, as I found, in the remnants of such colonies, substitution queens raised either from undestroyed eggs or very young individuals. It was, therefore, obvious that the whole nest must be destroyed so that no remnant capable of raising substitution queens was left; and not only the nest; but the containing timber, lest later some members of a nuptial swarm should find it a suitable place in which to settle and recommence the trouble. But if in the remains of the nest log, why not in other timber also. So long as suitable timber is left, even if all the *Termes gestroi* in the clearing have been destroyed, the conditions approximate to those of an uninfected new clearing, and in one night a nuptial swarm may re-infect the whole area.

I was thus driven to the conclusion that the only safe preventive and remedial treatment for *Termes gestroi* was absolute clean clearing.

During 1915 I was able to test the method on a peaty block suffering from the heaviest pure *Termes gestroi* attack I have seen. Surface timber was destroyed, stumps were blasted and lifted, and buried logs were prospected for with probes, dug out, and burned. The work was done thoroughly, and the result was excellent. One or two small areas showed re-attacks which were traced to hidden logs, but after these were taken out, no further white ant troubles arose in the block although previously the mortality ranged up to 75 per cent. of the 18 months old rubber. The method, then, was sound, but what of the expense? Would it really pay the average estate to put up the necessary money? I had faith that it would, considering the crop saved, and the reduction in working costs effected, so thereafter, whenever called upon to advise on white ant treatment, I insisted upon the fundamental importance of destroying timber. Some estates provided for the work—others carried on with careful application of their previous methods. But during 1914-15 our knowledge of the mode of attack of certain fungi upon the roots of rubber, and of their immense economic importance, was rapidly advanced, and the responsibility fixed upon decaying timber. With this extra, and even more important case against timber to support the policy of clean clearing, it became possible to advocate as a general estate method what previously might have been considered a counsel of perfection.

In February of last year at a Planters' Association lecture I first recommended the general adoption of this common-sense method. The idea did not at once meet with unanimous approval, but the progress it has made in little more than twelve months has been eminently satisfactory.

Early in 1916, also, I had the opportunity to devote some time to the consideration of coconut pests, and here too *Termes gestroi* proved to be by far the most serious pest, warranting a very considerable expenditure upon preventive treatment.

The same arguments for clean clearing apply to coconut cultivation as to rubber, beetle grubs in the rotting wood replacing fungoid diseases as the supporting reason.

That clean clearing is the only sure cure for *Termes gestroi* attack, I am fully convinced. Of all other methods tried, including the sulphur arsenic fumigator, it must be admitted that they have failed to eradicate the pest. In areas wherein *Termes gestroi* has become established, particularly in old rubber, the fumigator is indispensable, but only as an adjunct—not as the principal method. Within two, or at the outside three years of felling, every available shelter for *Termes gestroi*, and consequently every likely infection centre for root diseases should have been destroyed.

That clean clearing is in general worth while from a financial view point, I am satisfied also. But this is a matter upon which the economist and not the scientist will decide.

To the practical planter belongs the solution of the problem, how best and cheapest to get rid of the undesired timber; whether by double felling; by single felling and clean clearing before planting; by single felling and clearing when the rubber is well up; by disposing of the wood for charcoal or firewood; or what not? The sooner the cheapest and the most effective method is established, the earlier will this, the most desirable of all plant sanitation methods, become a piece of the established routine of estate opening.—AGRIC. BULL. F.M.S. VOL. V., No. 8 & 9, May & June, 1917.

WHITE GRUBS IN PORTO RICO.

EUGENE G. SMYTH.

Acting Entomologist of Porto Rico Experiment Station.

The worst general pests of crops and orchards in Porto Rico are the May-beetles ("caculos,") and their young, the white-grubs ("gusanos blancos"). May-beetles are oblong, rather cylindrical, hard shelled insects, yellowish-brown in color, which hide during the daytime in the soil at the base of trees and plants, and come forth at night, flying to the nearest foliage, upon which they alight and feed. They are often attracted to lights in the early evening, but should not be confused with the hard-backs ("caculos prietos"), which are darker in color and flatter in shape, and do not feed upon foliage. In each locality on the Island there are two distinct species of May-beetle, the larger about an inch long and the smaller three-fourths inch or somewhat less. Usually the larger species is the more plentiful.

During the daytime while in the soil, the female May-beetles lay oval pearl white eggs about one-tenth inch long, which are enclosed in hard earthen cells. A female may lay thirty or more eggs in a month. In two weeks' time the egg hatches into a tiny white-grub, which lives at first upon humus in the soil, but soon begins to eat roots. Its growth is rapid, and it attains almost its full size in four months, becoming an inch or more across in coiled position. For four to five months more it continues to feed, devouring in that time great quantities of living plant roots. So voracious are white-grubs that eight or ten of them, under a single cane stool or young citrus tree, are able to stop its growth and cause it to become sickly. Yet there is little above ground to indicate what is causing the trouble, which may be attributed to disease or lack of fertility unless the ground be dug up to discover the real cause.

Nine months after hatching from the egg the grub becomes inactive, and changes to a brown pupa. In this condition it remains for three weeks, in a smooth oval cell in the earth, changing then to the adult May-beetle. This remains for another month or so in the soil, its legs and body meanwhile becoming very hard. Following the first drenching rain that softens the soils as deep as its cell, it digs its way to the surface and begins to feed upon foliage. The adult lives from two to three months above ground, eating as great quantities of foliage as it did roots while a grub. A month is required after emerging before the first eggs are laid by the female. The entire life-cycle of May-beetles requires in Porto Rico about one year.

Methods of controlling white-grubs are both difficult and expensive. No poisons have yet been used against them with success, and the putting of deterrents, such as lime or chemical salts, into the soil is only partially successful. Natural enemies are not sufficiently numerous to keep them in check,

and the introductions of foreign parasites have not yet given results. The use of chickens, turkeys or hogs behind plows, to pick up the grubs is highly recommended ; but these must be fed with grain during half of the year, when there is no plowing, and the high cost of grain in Porto Rico makes this method prohibitive. Blackbirds destroy many grubs, but are not sufficiently plentiful in most localities, to give relief from the white-grub menace.

The only economical method yet found for controlling white-grubs and May-beetles, whether in Porto Rico or in foreign countries where these insects are a menace, is hand picking of grubs behind the plows, and gathering of the beetles from foliage at night by use of lanterns. Boys are paid at a stipulated rate per quart for grubs and beetles. This practice is common in Europe, Australia, Java and Mauritius, as well as in Porto Rico. Some idea of the cost of hand picking on a large scale may be gained from the following figures, compiled from the data kept by GUANICA CENTRALE. During the two years of 1914 and 1915, a total of 369 bushels of beetles and 426 bushels of grubs were gathered from five haciendas in the Guanica District, at a cost to the central of $6,154·37. And still white-grubs are increasing in that district, as elsewhere on the Island.

An exhaustive article is now in press (in the JOURNAL OF THE PORTO RICO DEPARTMENT OF AGRICULTURE, Vol. I., No. 2) which describes and illustrates fully the stages in the life-cycles of several Porto Rican white-grubs, and the parasites which prey upon them. There is great need at present, however, for a publication which will give to the Porto Rican public the best known methods for controlling white-grubs.

The Insular Experiment Station desires to co-operate with the United States Department of Agriculture in an attempt to enlist the aid of all farmers and fruit-growers in the present crisis, in increasing food production by minimising in every way possible the ravages of insect pests to staple crops and fruits. We feel that in no better way can this be done than by striving to suppress the ravages of white-grubs on the Island. With this object in view, a list of pertinent questions relating to the local occurrence of May-beetles and white grubs and methods that have been tried for their control, has been drawn up and is being mailed to colonos and fruit-growers over the Island. It is hoped that this request for information will meet with prompt response. The data contained in the answers to these questions, added to what knowledge of control methods of grubs has been gained by agents of the Experiment Station during the past six years, will be published as soon as possible and in such a way as to give full publicity to the subject and enable every grower of fruit and other crops on the Island to know the latest and most approved methods of combating these very destructive insects.—PORTO RICO PROGRESS, May 18, 1917.

PLANT SANITATION.

COCONUT DISEASES AND PESTS IN JAMAICA.

The following extracts from the Annual Report of the Department of Agriculture, Jamaica, for 1916-17 are of general interest :—

FUNGUS DISEASES.

Budrot.—A marked increase of the disease has occurred specially in some of the eastern parishes. The increase is very probably connected with hurricane injury, and exceptional rainfall during the last two years.

The most serious increase has taken place in St. Thomas. It has been especially marked following the hurricane of August and the abnormally wet months of October and November. Fortunately the following months were comparatively dry so that the thorough destruction of diseased buds proceeded under favourable conditions. In addition to the preventive measures required by law (prompt cutting down and thorough burning of diseased buds), applications of various chemicals and chemical mixtures to the buds of healthy trees have been made with a view to warding off infection. The applications most in favour are bordeaux mixture, bordeaux paste, and lime and sulphate of copper powder (dry mixture), but lime and coarse salt mixture and rock salt alone have been used also on a smaller scale. On some estates arsenate of lead has been added to the bordeaux mixture (2-4 pounds dry powder to 50 gallons mixture), with a view to controlling the insect scavengers liable to carry infection from diseased to healthy buds. The abnormal weather in the autumn, by washing off the applications and partly or wholly stopping the work, seriously obscured the effects of this treatment, but the more favourable weather since should enable definite conclusions to be drawn as to its preventive value. The treatment described has been carried out on lines recommended by the Microbiologist who visited the district twice, arranged for monthly reports of the work to be sent to him and has kept in close touch with the estates by frequent correspondence. The disease is in evidence throughout the Island wherever there are extensive areas in coconuts.

The systematic destruction of diseased trees in some of the western parishes carried out by the Inspector of Plant Diseases during the preceding year has been discontinued owing to demands on his time in the eastern parishes. A resident inspector for the western section is needed.

Leaf Bitten Diseases.—These diseases have become very conspicuous along the whole north-coast during the last two years. Four kinds of the Leaf Bitten condition have been observed, due to four distinct agencies, each as a rule, acting alone.

1. The most general form of the disease on the north-east coast during the year has been due to infection of the young leaves in the heart, by the pine-apple fungus (*Thielaviopsis paradoxa*, von Hohnel). The fungus attack

on some estates has been followed by the striped weevil borer (*Motamasius sericeus*). The larva first attacks the fungus diseased patches on the young leaflets, but may continue its work beyond them into the leafstalk, and so enlarge the damage caused by the fungus. As the disease may terminate in Budrot the rather drastic treatment was advised of cutting away the bud until all the diseased tissue was removed, burning the prunings and applying lime-sulphate of copper dry mixture to the heart. Treatment is now being applied on a large scale and after some months it will be possible to judge of its value.

2. A considerably smaller proportion of trees are affected by a form of the disease in which the young limbs show long, raised, cracked, brown, very hard, patches on the upper surface; the leaflets are also affected and wither, and break off leaving stumps on the hard brown stalks. A small yeast is the only organism found regularly in the diseased tissues and appears to be the cause of the trouble. In advanced cases the heart may harden and die, killing the tree, or pass over into Budrot. If taken in time the treatment for Pine-apple Leaf Bitten has been found effective also against this Hard Leaf Bitten Disease.

3. A few cases of spotting on the adpressed leaves in the heart have been found due to a downy mildew—a species of *Phytophthora*. Some of these cases also showed attacks by normal bacterial Budrot.

4. On the north-west coast a Leaf Bitten condition has been observed due to rhinoceros beetle (*Strategus* sp.)

Leafscar Disease.—In this disease the scars left on the trunk by the fallen limbs instead of becoming normally smooth, white and hard, become dark, spongy and cracked: the decay is quite shallow but the surface scales off and in time a depression up to two inches in depth is formed. A secondary rot favoured by water is liable to develop behind the bark below affected scars and may hollow out the stem of the tree.

The disease was investigated last May in Hanover, St. James and Trelawny, but found bad on only a few estates. Scraping and treating with coal tar has been found to stop the disease. A fungus was isolated from diseased scars and found to be a *Cylosporella* or closely related to that genus.

INSECT PESTS.

Coconut.—From Trelawny, leaves were blackened by sooty mould as a consequence of attack by *Cerataphis* sp. This insect may readily be mistaken by planters for an Aleyrodid or Scale.

The glossy star scale, *Vinsonia stellifera*, Westw., assumed injurious proportions on coconuts just coming to good bearing on an estate in Western Portland. It was certainly unusual to see this generally distributed scale in such numbers and the leaves were badly blackened. As many as 70 to 80 scales of varying ages could, in instances, be counted per square inch of pinnule under side surface!

On the Liguanea Plain, *Pseudoparlatoria ostreata* was in cases abundant but was being heavily parasitized by the cinnamon fungus, *Verticillium heterocladum*. Penz. *Pseudoccus nipæ*, Mask. was also present. Material from St. Thomas showed *Pinnaspis buxi*, Bouche. on the leaves in quantity with *Diaspis boisduvalli*, Sign., common on the leaf bases.

At the present time, scale on coconut would not appear to be generally a problem with planters but from the writings of MORRIS and FAWCETT, (*Bulletin of the Botanical Department of Jamaica*, No. 4, Nov. 1887, p. 6, and No. 6, March 1888, p. 6) scale may increase to most injurious numbers on coconuts in the Colony. Unfortunately the scientific determination of the species complained of in these writings is not given.

The common coconut beetle of the island is *Strategus titanus*, F., (male, with central horn angular and with tendency to bifurcate; female, hornless;) but this only spasmodically gives trouble by injury to the cabbage, especially of younger palms. Digging out the beetles by hand, or the pouring into the wound or burrow solutions of Jeyes or carbolic dips are the methods of combat adopted. The damage by this beetle (ragged edges of pinnules, circular holes in pinnules, etc.,) should not be confused with the effects of the fungal disease known as "bitten-leaf" where there is as a rule blasting of the tips of pinnules with hardening and discolouration of the mid-rib.

From a sluggish specimen of this beetle taken on banana in St. Catherine (adults are sometimes found secreted in banana bunches) five specimens of *Sarcodexia sternodontis*, Towns, emerged. This species was previously recorded from the longicorn. *Sternodontis damicornis*—the type host, and the scorpion *Centrurus edwardsi*, Gerv. (JNL. OF THE INST. OF JAM., vol. 1, pp. 105-6 and p. 221).

Palm stems attacked by the pinhole borer, *Xyleborus sp.*, were occasionally seen. Attack may be recognised by the exudation of beads or patches of reddish gum and the general rusty red appearance of the stem due to the dried exudates. For treatment emulsions of Carbolineum are good. Such palms if left untended succumb to the attack in eight months to two years.

The presence of the brown weevil *Metamasius sericeus*, Oliv. in coconut plantations may be taken as indicative of existing diseased or wound conditions. The grubs are to be found working in the tissue of leaf midrib and unfolded pinnules discoloured by "bitten-leaf" disease, etc. Its attacks so far as our knowledge at present goes is not primary! Banana bulbs if left in piles above ground to await planting attract the weevils in considerable numbers and the material will be egg-lain, and breeding will commence. This form also frequents and breeds in felled banana stems and waste left in the fields after crop if not cut up and spread to dry out quickly. As this weevil is a denizen of diseased or dying tissue, it would be well to control its numbers by trapping the adults in such material as it is found regularly to frequent, in order to avoid the high possibilities of disease dissemination in fæces and mechanically on the body. Arsenate of lead, added to the Bordeaux mixture ($2\frac{1}{2}$ lb. per 40 gallons Imp. of mixture) used in such disease cases might be tried. Such arsenates are only effective for from five to seven days and have in themselves no germicidal or fungicidal value. The attacks of this weevil on sugar-cane in this Colony are referred to in the early writings of SAMUEL KELL KING of Portland. (See GOSSE, NATURALIST'S SOJOURN IN JAMAICA," pp. 451-5.) The attack here again is secondary following moth-borer stem-injury by rats or storm, cutting over of cane, etc. KING considers the weevil an introduction from Tahiti in cane varieties about 1797.

PLANT DISEASE CONTROL IN JAMAICA.

In view of the discussion at the last meeting of the Committee of Agricultural Experiments of Ceylon in regard to the control of plant pests and diseases the following extract from the Annual Report of the Department of Agriculture, Jamaica, for 1916-17, is of interest:—

Owing to the demands for work in connection with the Plant Diseases Law it was found necessary to appoint an Acting Inspector in place of Inspector SCUDAMORE who is fighting in France, and there was a full demand on the services of the two Inspectors throughout the year.

With regard to Panama Disease of Bananas I am glad to be able to report a substantial reduction in the record of plants affected with this disease. No new parish was found to be infected during the year but two new foci in Portland and one in Hanover were reported. The records of the incidence of Panama Disease for the year are as follows:—

Record of Cases of Panama Disease of Bananas, 1916-17.

Parish.	Total No. of Diseased plants.	New Districts Infected.	New Cases.	Recurrences.	Total Cases.
1. Portland	140	2	25	8	33
2. St. Mary	7	...	...	2	2
3. St. Ann	4	...	2	1	3
4. Hanover	12	1	1	1	2
Totals for Islands	163	3	28	12	40

Record of Diseased Plants for whole Island—6 Years, 1911-17.

1911-1912	685	First discovery of disease.
1912-1913	20	No inspectorate.
1913-1914	156	Inspector provided.
1914-1915	168	,, ,,
1915-1916	236	Two inspectors provided.
1916-1917	163	,, ,, ,,

The total number of plants affected was 163 or less than in any year since 1913-14. When this disease was first discovered at Balcarres in the Buff Bay Valley of Portland in 1911, 685 diseased plants were discovered and treated. In the succeeding five years the total incidence of this disease for the whole island has been only 743 plants in all. I submit with some confidence that this record is satisfactory evidence of the effective measures that have been taken by the Department to deal with cases of this very serious and troublesome disease wherever it has been discovered. The results of the treatment of cases on large properties, where the rules have been carried out with scrupulous care and fidelity, have in all cases been a successful stamping out of the disease. In the Buff Bay Valley where there are numbers of Small Settlers on unfenced lands to be dealt with, it has been impossible to prevent frequent breaches of the rules and a regrettable recurrence of disease.

At the same time, all cases have been thoroughly treated by the Department as they arose and the latest results indicate that the disease is now showing a marked diminution in this area.

AGRICULTURAL EDUCATION.

HISTORICAL SKETCH OF THE PROGRESS OF HIGHER AGRICULTURAL EDUCATION IN THE BOMBAY PRESIDENCY.

The initiation of higher agricultural education in the Bombay Presidency dates from the year 1878. At that time, partly as a result of one of the most severe famines of the nineteenth century, general attention was turned to the possibility of increasing the resisting power of the country to famine by an improvement in the agricultural methods in practice. As a result, classes were founded at the College of Science, Poona or rather at the Poona Civil Engineering College, as it was called until a year or two later. At first the course was elementary. The object was more especially to produce men who should occupy the position of *bhag karkun*, known in other parts of India as Revenue Inspector of Kanungo. Men who had successfully passed through the classes were granted the same privileges in the public service as those who had passed the First B.A., now known as the Intermediate Examination of the Bombay University. When first instituted, the classes in Agriculture formed a two-year course, and they opened with thirty students. Scholarships on a fairly liberal scale were offered. Unfortunately, however, there were few suitable openings for passed students, and the numbers attending the classes soon fell off.

A step in advance was made in 1880 by introducing a practical element into the course. A farm, ultimately made up to seventy-two acres, was acquired near the College of Science and used regularly for the instruction of the students. It was fenced in and brought into a highly efficient state under the management of PROFESSORS S. COOKE and D. N. NAGARKAR, while, subsequently MR. SHEARER became manager of the farm.

Soon after this came the report of the Famine Commission in 1881, which recommended the creation of agricultural departments throughout India, with officials in every district, whose business it would be to watch over agricultural interests, to collect information, *facts*, about agriculture, and to make recommendations or to carry into effect suitable measures for the improvement of the agricultural population. To carry out adequately the suggestions of the Commission it was recognized that men with a higher agricultural training than had hitherto been obtainable were necessary.

The then Director of Agriculture (MR. OZANNE) framed a scheme for such higher agricultural training. This was considered by a Committee, which in 1885 made the recommendation that, if possible, the Bombay University should be induced to grant a degree in agriculture, and frame a course and an examination which would involve a thorough training in the subject and those connected with it. The Bombay University, after long consideration, did not at that time (1890), however, see its way clear to grant a degree in agriculture, but instituted, instead, a Diploma. To obtain this involved a three years' course at the College of Science or the Baroda College, and thus, for the first time, agriculture received University recognition.

The result of the change was that, from that time onward, for sever years, a considerable number of men were trained in the agricultural classes, MR. JAMES MOLLISON, being Professor of Agriculture, and Agricultural Chemistry being taught first by MR. S. H. COLLINS and afterwards by MR. J. W. LEATHER, Agricultural Chemist to the Government of India. The numbers in the classes, however, rapidly, fell off, as, owing to the rules for entrance into Government service, the men who had obtained the Diploma in Agriculture were given no advantage, except a preferential right to minor appointments over those who had merely matriculated at the University. As most of the students entered the course with the idea of turning their agricultural training to advantage in the public service, it was natural that, as they found the Diploma gave no preferential rights to higher posts in that service, further students ceased to come.

The number attending the agricultural classes, hence, fell to four in 1893, and to three in 1894, while there were none at all in 1895. Not a single student obtained the Diploma in Agriculture from the College of Science, from 1897 to 1901 inclusive.

In 1897 the first step was taken to remove the causes of the unpopularity of the agricultural classes. The standard of admission to the course was raised from the Matriculation to the "Previous" Examination, and in consideration of this fact the Government agreed to give the same privileges to men who had obtained the agricultural diploma as to graduates of the University. Interest, however, did not at once revive. The attendance, in fact, remained at vanishing point in 1898 and 1899.

A further change took place in 1899. The Diploma course had long been evidently unsatisfactory, and a general demand existed for an agricultural degree, to be given by the Bombay University. At last, in September 1899, the University consented, and established a regular course leading to the degree of Licentiate in Agriculture. The "Previous" Examination was made the entrance to the course, and a thorough training in Agriculture, Chemistry and Natural Science was demanded. Special stress was laid on the importance of the training in Practical Agriculture.

The course then laid down was that under which the agricultural classes were carried on until 1907.

In the meantime, higher agricultural training has become popular. The number of students who have received the degree each year are as follows:—

1901	none	...	1907	11	...	1913	14
1902	1	...	1908	21	...	1914	18
1903	2	...	1909	26	...	1915	20
1904	3	...	1910	36	...	1916	23
1905	6	...	1911	20		1917	30
1906	7	...	1912	22			

The increase in the popularity of higher agricultural education is partly due to a general increase of interest in agriculture which has arisen since the terrible series of famines from 1896 to 1901, and partly to the development of the Agricultural Department of the Government of Bombay and the need of trained men to fill the various positions in connection with it. It is also due partly to the fact that holders of Agricultural degrees have been given, not

only the same privileges as other graduates possess in the matter of admission to and promotion in the Revenue Departments of Government, but also, if otherwise qualified, a preferential claim to posts in the Agricultural Department.

The increase in the size of the agricultural classes caused such a congestion at the College of Science that during the year 1905 it was decided by Government to establish a separate Agricultural College. A fine site for a College and farm of nearly one hundred and fifty acres was secured near Poona, and plans for a first class College and Research Institute were drawn up. The buildings required for teaching and the students' quarters are now completed. The smaller block, intended for Chemistry and Physics, was completed and the whole college work was transferred to it in May 1909: the larger block, containing large College hall, museum, herbarium and adequate facilities for teaching and research in Agriculture, Botany, Mycology and Entomology, was finished in 1911, and occupied. The buildings were formally opened by HIS EXCELLENCY SIR GEORGE CLARKE, Governor of Bombay, early in July 1911.

While awaiting the completion of these buildings, the College was temporarily located in a series of houses at Kirkee which had been adapted for College purposes, and the final separation from the College of Science took place on January 1st, 1908. The College, as now constituted, is under the final control of the Director of Agriculture, Bombay, in consultation with the Director of Public Instruction. The executive charge is vested in a Principal, who is supplied with a staff of two Professors, and a sufficient number of Assistant Professors, Lecturers and Demonstrators.

Coincidently with the complete separation of the Agricultural College from the College of Science, the Bombay University made a further change in the course for the degree. The scope was extended the standard raised, and the graduates from 1909 have the title of Bachelor of Agriculture. The dates of the session were also altered, and it now runs from June to mid-February, so that attendance at the College now covers the most important agricultural months of the year in the Bombay Presidency.

During the year 1909-10 further changes were made by the University in the Agricultural curriculum, as that which had been introduced in 1908 was found to be practically unworkable. In 1916, acting on the report of a specially appointed committee, the University passed revised regulations for the Examinations in Agriculture. These are printed in the present calendar. They are designed to reduce the number of examinations and to enable the students to specialise. It is believed that the result will be to turn out men who are, in their special lines, more expert than those produced by a uniform general course. A degree of Master of Agriculture was also instituted in the year, and its regulations are also printed in this calendar.

On account of the hostel (with its out-houses) and the main block of the College being given up for use as a war hospital the indoor work in 1917-18 will be carried on in the chemical block and two lecture rooms of the main block, and special arrangements will be made for the accommodation of students outside the College estate. The Short Course is held in abeyance for the present year.—CALENDAR OF THE AGRICULTURAL COLLEGE, POONA, 1917-18.

SCHOOL OF TROPICAL AGRICULTURE, PERADENIYA.

REPORT ON WORK OF FIRST SESSION 1917—1919 COURSE.

The session commenced on May 9th and closed on September 29th. Thirty new students were admitted. They classify according to the provinces from which they come as follows :—Southern 12 ; Western 9, Central 3, Northern 3, North-Western 1, Sabaragamuwa 1, and Uva 1. Four others joined the class, of whom 3 had partly completed the course and one had passed out in December 1916. The English Class thus consisted of 34 students.

Classes for Sinhalese and Tamil Headmen commenced on May 15th. Sixteen headmen in all were admitted, 13 Sinhalese and 3 Tamils, representing 7 provinces and 9 districts. Sabaragamuwa and the North-Central Provinces were unrepresented.

ENGLISH CLASS.

	No.	Age			Nationality				Weeks of Work.
		Max.	Min.	Aver.	Sinh.	Tam.	Burgh	Malay	
Students ...	34	24	18	21	25	5	3	1	21

One student is non-resident, and four live with one of the lecturers, The rest (29) are accommodated in two Government Hostels,—Irene Hostel (19) and Green's Hostel (10). The students leave their hostels at 6·30 a.m. for fieldwork and return for breakfast at 11 a.m. Lectures in the classroom begin at 1 p.m. and close at 3 p.m. The recreation period is from 4 to 6·30 p.m. ; the students are members of the Departmental Cricket Club and have a Tennis Club of their own. Dinner is at 7·15 p.m. Supervised Study from 8-9 p.m. Lights are out at 10 p.m.

Fieldwork.—All students attend plot work together. In Planting and Horticultural Demonstrations, the students attend in batches of seventeen at a time, so as to ensure more individual attention. All fieldwork periods extend over two hours. The students engage in all operations themselves ; no outside labour is allowed. All demonstrations follow the actual routine of Planting and Horticultural work in progress.

Plots.—Tillage, draining, allocation, cultivation, nurseries, harvesting, clearing plots, tillage. Each student grew a grain, a pulse, and a vegetable on $\frac{1}{16}$ acre. The crops cultivated were : Sorghums, Maize, Ground-nuts, Brinjal, Bandakka and Chillies. Dhall sown in advance for next session. Growth of crops studied and observations recorded in Plot Diaries. A careful watch was kept for Pests and Diseases and remedial measures promptly taken. A common plot of the following curry stuffs was planted out in beds and tended by the students in rotation: Mustard, Coriander, Cummin, Aniseed, Fenugreek. This plot also contained Dhall and Chillies. The plotwork was careful and good throughout. The plots were visited by the HON. the GOVERNMENT AGENT, C.P. on 13th September, 1917, and he commented on the good work done on the plots.

Planting.—Coconuts: selection of nuts, nurseries, planting out, subsequent treatment. Manures,—kinds, mixing, application. Rubber,—diagonal lining, planting out. Cacao,—varieties, diseases, pests, seed selection, nurseries, manuring, transport, market. Coffee,—Past cultivation, kinds, soil and elevation, planting out. Tea,—pruning. Paddy,—harvesting.

Horticulture.—Nursery work, pot culture, pruning of fruit trees, root pruning, propagation by seeds, spores, cuttings, leaves, runners, corms, eyes and roots, gootee layering, ribbon bedding, tree felling and root extraction, packing and transport of seeds and plants, road making.

Lecture Work.—The lectures are given in the classroom and occupy one hour each. Two consecutive lecture periods are combined when necessary for demonstration or microscopical work. Lectures are carefully arranged to follow the fieldwork so that theory and practice may go hand in hand as nearly as possible; and that the student may be able to correlate his fieldwork to his classwork and be able to verify and fix his lecture-work by observation and demonstration in the field. The following lecture periods have been given during the session. Plant 43 periods, Chemistry 38, Animal 34, Economic Products 19, Soil 17, Pests 19, Implements 15, Agricultural Economics 9, including Co-operation 4. The students write up their lectures in notebooks which are examined and marked weekly by the lecturers. Sectional revision and Tests are distributed throughout the session.

HEADMEN'S CLASS.

In terms of Sessional Paper XXXVII, 1909, paras. q. & t., Government Agents were circularised with regard to a course for Headmen in Agriculture. Arrangements were based on the replies received and considerations of accommodation in Peradeniya. A house was rented and furnished to accommodate 16 headmen, and the following were admitted: 2 Koralas, 1 Native Writer, 8 Police Headmen, 4 Arachchies, 1 Vel Vidane.

Field and Lecture Work.—The plotwork has been similar to that of the English Class, the crops cultivated being Maize, Kurakkan, Lima Beans, Chillies, .Green Gram, etc. Demonstrations in Planting and Horticulture have varied slightly from the programme of the English Class enumerated above in order to suit the particular needs of these men. All work was conducted in the vernacular. The weekly programme allows 4 mornings for fieldwork, 2 for notebook work and 5 afternoons for lecture and demonstration work. The theory work has been reduced to a minimum and demonstration and field work periods proportionately increased. The work covered two-thirds of the work prescribed under Plants, Economic Products, Pests, Animals, Chemistry, Soils, Manures, Implements, and Co-operation.

GENERAL.

The Visiting Medical Officer, Kandy, inspects the hostels weekly on Wednesday afternoons. The health of the students has been satisfactory on the whole. The average attendance has been 93%.

On Saturday, May 12th, the first Prize Day of the school was held on the grounds of Irene Hostel. The HON. MR. C. S. VAUGHAN, Government Agent, C.P. presided. The speakers were MR. E. B. DENHAM, Director of Education and the HON. MR. T. B. L. MOONEMALLE. Six gold medals were awarded, and six silver medals. MRS. VAUGHAN presented 53 school diplomas of the English Class and 6 of the Vernacular Teachers' Class to the successful candidates of the 1916 course.

MR. H. L. DE MEL visited the school on July 13th and went round the plots and classrooms. He addressed the students on "Punctuality, Precision and Promptitude as Business Qualities."

The REV. H. HIGHFIELD addressed the students on August 22nd on "Some Ideals of Student Life" with special reference to agricultural students.

ST. L. H. DE ZYLVA, Registrar.

CO-OPERATION.

CO-OPERATIVE CREDIT SOCIETIES, CEYLON.

REPORT OF THE REGISTRAR OF CO-OPERATIVE CREDIT SOCIETIES FOR 1916-17.

ADMINISTRATION.

The Co-operative Credit movement in Ceylon was commenced in 1913 under Ordinance No. 7 of 1911. During the first year 31 societies were registered, in 1914-15 23, in 1915-16 1, and for the period under review 16, making a total of 71.

2. The Director of Agriculture acts as Registrar, and I assumed charge of the societies in December, 1916, relieving MR. T. PETCH, who had been acting since the resignation of MR. R. N. LYNE.

3. On taking over duties I found that the Ordinance prescribed that annual general meetings of all societies be held during the month of April, when accounts were to be audited and balance sheets presented. Actually very few societies had held annual general meetings since their registration, and fewer still had had their accounts properly audited. It, therefore, seemed highly desirable that annual general meetings should be held by all societies, and that all accounts from the dates of registration up to March 31,1917, should be thoroughly inspected by Co-operative Credit officers, audited, and balance sheets prepared. This was represented to Government, which provided the necessary funds for travelling expenses in connection with this complete inspection. The registrar attended 26 annual general meetings, and inspected and audited these societies' accounts. The remainder were carried out by the Secretary of the Board of Control and by the Inspector for Tamil societies. As the result of these inspections, complete statements of accounts can now be presented, and in future years checking accounts will not be such a lengthy undertaking, as was found to be the case during the present year, especially of those societies that had not had their accounts inspected since their registration. It is proposed in future to have accounts checked every six months, so that the Secretary and Inspector will be frequently travelling, with the object of teaching the office bearers of existing societies the principles of co-operation and account-keeping, and of carrying on propaganda work with a view to starting new societies.

4. The Board of Control held no meetings during the year, but several matters connected with Government loans, pass book forms, and by-laws of societies were submitted for their consideration and advice.

5. The Secretary of the Board was on tour 101 days during the year. He attended the inaugural meetings of 13 new societies. The Inspector appointed for societies in Tamil districts was on tour 36 days.

6. A new form ("Inspection Report") has been adopted for the use of inspecting officers, and copies of these reports are sent to the Provincial Revenue officers as issued. A new form of pass book has also been adopted after approval by the Board of Control, as previous forms were considered to be unsatisfactory.

SUMMARY OF PROGRESS.

7. The general progress made during the year under review is shown in the following table:—

	Type of Societies.		
	Agricultural.	Non-Agricultural.	Total.
Number of Societies:—			
1915-16	54	1	55
1916-17	68	3	71
Number of members:—			
1915-16	4,036	32	4,068
1916-17	5,966	61	6,027
Paid-up capital:—	R. c.	R. c.	R. c.
1915-16	20,059 50	175 50	20,235 0
1916-17	32,707 75	286 50	32,994 25
Reserve fund:—			
1915-16	1,462 92	2 24	1,465 16
1916-17	3,222 7	23 65	3,245 72

The 16 new societies registered during the year were as follows:—

Agricultural: Siduwa, Haltota, Dakunu Talangama, Pandatarippu, Karaveddi, Puloli, Valikamam West Headmen's, Annaikodai, Mahagama, Maha Pattu North, American Mission Agents,' Kandyan Association, Unanwitiya, and Panadure-Talpitibadda.

Non-agricultural: Colombo Plumbago Employees' and Mannar East Fish Supply Co-operative Societies.

8. Of the 71 societies existing at the end of the Co-operative Credit year, 68 were agricultural societies. Three of these are of the type of central societies and 2 of them are not working. Of the non-agricultural societies, one—the Jaffna Industrial Society—works for the benefit of gold and silversmiths, who obtain from the society stocks of gold and silver for working up orders which they may receive either individually or through the society. Another is the Mannar East Fish Supply Society, registered in July, 1916. Its objects did not conform with the requirements of the Co-operative Credit movement, and therefore it will be dissolved. The third is the Colombo Plumbago Employees' Society, for loans to workers in plumbago sheds.

9. Of the 68 agricultural societies, 57 are of unlimited liability and 11 of limited liability. In future no agricultural societies of limited liability will be registered, as the watchfulness of members upon the working and business of other members is increased when the societies are unlimited, and eventually the spirit of trust is improved.

10. The actual classification of the societies is as follows:—

Number of societies: 53 working. Classified:—A=good, 26; B=fair, 22; C=bad, 4; D=recently formed, 1.

Eighteen not working at present. Classified:—Registered only, 8; registered and collected some share money, 5; registered and collected some share money, but now at a standstill, 5. Steps have been taken to cancel 2 of the registrations of the societies not working, and unless the other 16 show signs of activity during the year, it will be advisable to arrange for the cancellation of their registrations and for a liquidation of their assets.

11. The above statement cannot be considered to show satisfactory progress for four years' working, and I have been at some pains to inquire into the reasons thereof. They appear to be as follows:—

(i) The Co-operative Credit movement is at present very little understood in the Colony. The principles of the movement and the benefits to be derived therefrom have not been grasped by any great number of the people.

(ii) Many of the Presidents of the societies have their time fully occupied with official duties under the Revenue officers, and can find little or no time to attend satisfactorily to duties imposed upon the President of a Credit Society. There are a few notable exceptions, where Presidents make it a business to combine their Co-operative Credit Society work with their official duties, and in all such cases progress of the societies under their charge has been satisfactory.

(iii) *The difficulty of finding suitable Office Bearers.*—The success of every Co-operative Credit Society depends upon the efforts of the office bearers, and in the absence of personal attention by the President, much of the working of the society devolves upon the other office bearers. There have been difficulties in obtaining satisfactory officers for secretaries and treasurers, but a gradual improvement is being noticed as experience is gained.

(iv) *The Effects of the Riots have been most marked.*—Most societies in those areas affected by the riots of 1915 stopped all work, and many only re-commenced operations of any kind in the early part of 1917. Many of the overdue loans were loans which had been issued previous to May, 1915, and in localities where compensations for riot damages have been heavy very little progress is even at present being made. Members of Co-operative Credit Societies in the districts where the riots were serious appear to have lack of confidence in the societies, but this feeling will doubtless disappear with the progress of time.

(v) *Insufficient Supervision.*—The progress of societies can only be slow, unless the office bearers are assisted constantly from the beginning. Assistance by correspondence is of little use, as the personal factor is a very considerable one, and much more can be done by a personal visit to a society's meeting, or even to a committee meeting, than by months of correspondence. The Secretary and Inspector should be constantly visiting existing societies, as they can help them considerably during the early stages.

(vi) *Conservatism.*—Many societies are far too conservative in their outlook. They have collected some moneys and have kept them locked up, because they have had no demands for the same. It is the duty of office bearers to see that there is this demand, for any society that does not attempt to have all its funds constantly out on loan is not conferring the maximum benefit upon its members. The demand of many villagers for money is very small, but several societies that experienced difficulties at first in getting loans started have been able to create a lively interest in their work and to confer benefits upon their members by purchasing manures and seed paddy for distribution in lieu of cost.

From the above remarks it is obvious that some reforms are necessary if further progress is to be looked for, and these are now under consideration, in conjunction with a scheme for re-modelling the agricultural services of the Colony.

WORKING OF SOCIETIES.

12. The balance sheet, which is appended* shows the position of the societies on March 31, 1917.

13. The number of contributing members of societies is at present 6,027. Members who have not paid their share contributions have been removed from the registers. The increase of members during the year is satisfactory, but the greater part of the increase is due to the formation of new societies. During the first few months of 1917 some of the older societies were able to enrol further members.

*Not reproduced.

14. The paid-up capital is Rs. 32,994, in place of Rs. 20,235 on March 31, 1916. The present paid-up capital is only Rs. 5 per head. This is absurdly small, and indicates that most societies are not yet in a position to be of any substantial help to their members. The capital of all societies requires immediate increase, and an effort should be made during the year to encourage members to take a greater number of shares. There are few members that have taken any shares after their original allotment, which indicates that use of the societies as an encouragement to thrift has not as yet been sufficiently realized.

15. The number of loans granted to members was 956, of an amount of Rs. 28,381·36. 504 loans representing Rs. 15,222·37 were recovered during the year. On March 31, 1917, a total of 680 loans representing Rs. 27,818·60 were outstanding, of which 159 representing Rs. 4,099·60 had passed their due dates. Loans were issued for the following purposes:—Cultivation, purchase of cattle, seed paddy and manures, leases of lands, purchase of land, redemption of debts, carpentry, basket-making, purchase of carts, hackeries, and for the purchase of produce for subsequent sale. The repayments of loans are very regularly made in a large number of societies, but there are still a few societies where punctuality of repayment is not the rule. In one instance only did a society have to grant extensions of loans on account of failure of crops. In the others negligence appears to be the chief contributing cause to the non-payment of loans. It is also most noticeable that villagers rarely fail in the payment of debts on due dates, and that the majority of defaulters are men who from their education should have endeavoured to have set good examples for other members. This is regrettable, and probably indicates that the best results may be obtained with the minimum of trouble with overdue debts by encouraging small societies amongst the villagers themselves. In several instances instructions have been given for overdue loans to be recovered from the sureties, but it is probable that in a few instances further prosecutions will have to be entered. Several societies have approached the Registrar for the settlement of disputes over overdue loans by exercising the power vested in him under rule 12, head *(q)*, section 27, sub-section (2), of the Ordinance, and this matter is receiving consideration.

Recourse was had by two societies to the Gansabhawa courts to recover overdue loans. These loans were only overdue by short periods, and action was taken by the committee as a warning against future defaulters. In most cases the moneys due were paid before the actions came before the court.

16. *Government Loans to Societies.*—One society—the Pandatarippu—received a loan of Rs. 1,000 from Government during the year. The following table shows the loans made by Government to date:—

Name of Society.	Amount.	Repayment.	Balance outstanding.
	Rs.	Rs.	Rs.
Walapane ...	660 ...	... 132	... 528
Hinidum Pattu ...	225	... 45	... 180
Kalapaluwawa ...	250	... 50	... 200
Kumbukke Pattu ...	1,000	... —	... 1,000
Pandatarippu ...	1,000	... —	... 1,000
Total...	3,135	227	2,908

17. Applications for loans are considered by the Local Loans and Development Commissioners before being granted. Loans are at present given on the recommendation of the Registrar in amount up to an equal

amount of a paid-up capital of the society for periods of ten years at 4½ to 5 per cent. interest per annum. These loans, with interest to date, have to be repaid in ten annual instalments, and it is proposed that in future the first instalment shall be payable only two years after the receipt of the loans.

18. *Deposits.*—The amount of money on deposit is Rs. 486·84. This is a small amount, but better results cannot be looked for at the beginning, when members have to meet their share payments.

19. *Interest.*—The rate of interest charged on loans usually varies from 9 to 12 per cent., but some societies are charging as low as 6 and 8 per cent. The fixed rates of interest on deposits ranges from 2 to 4 per cent. It is probable that these rates require revision. Societies charging 12 per cent. interest on loans can afford to pay more than 4 per cent. on deposits, and if this rate were increased might be able to attract larger sums on deposit, thereby increasing their capital.

20. *Profits.*—The total profits realized by all societies during the year amounted to Rs. 2,423·51, and the expenditure Rs. 397·86 thus leaving a nett profit of Rs. 2,025·65. In a large number of societies the working expenses are met voluntarily by office bearers of the societies, and their public-spirited action in the commencement of the movement is commendable, and allows societies to be run with the minimum of expense. Four societies have declared bonuses, the amounts due to each member having been credited in their pass books.

21. *Reserve Fund.*—The total amount of all the working societies to the credit of the reserve fund is Rs. 3,245·72. In some instances it has been found necessary, in the case of societies with small working capital, to allow the use of the reserve fund for a further period of one year for making ordinary loans to members.

22. *Agricultural Implements.*—Two societies have begun the co-operative purchase and sale to members of agricultural implements. This assistance to members appears to be appreciated.

23. *Agricultural Experiments.*—Some of the more advanced societies are taking an interest in agricultural experiments. One society has undertaken an experiment in transplanting paddy, three others have carried out trials with paddy manures supplied free of cost by the Colombo Commercial Company, and another has distributed new strains of paddy for trial. Manures are also being applied as the result of the work of societies to betel and vegetables, and some societies have proposed to start gardens for the purpose of raising seed for distribution amongst members. These proposals are still under consideration.

GENERAL.

24. The Government has been pleased to sanction Government servants becoming members of Co-operative Credit Societies, and the following notice was published in the *Government Gazette* No. 6,864 dated March 30, 1917. This notice indicates the Government's favourable attitude towards the promotion of the Co-operative Credit movement in the Island, and will remove doubts of several public servants in regard to Government attitude towards the movement:—

"In order to remove any misapprehension, HIS EXCELLENCY THE GOVERNOR desires that it be notified for general information that there is no objection to Government servants becoming members of Co-operative Credit Societies registered under Ordinance No. 7 of 1911"

25. The Ceylon Co-operative Credit Ordinance is based on the Indian Act of 1904. This has been replaced by the Act of 1912, in which some considerable amendments have been introduced. It is probable that the Ceylon Ordinance will require to be brought up to date, and amendments are

under consideration. Further rules will have to be framed, and it is probable that a complete consolidation of all rules of Co-operative Credit Societies will require to be undertaken in the near future, when further experience of local conditions has been gained.

26. The want of knowledge of co-operative principles underlies many of the difficulties of the present, and instructions in the details of practical working of societies are required before great progress can be looked for. The practice at present is to form societies covering large areas; and whereas this may not appear to be the best policy from the co-operative point of view, a large number of minor headmen are receiving thereby instruction in the principles of the movement, and will be capable later on of taking charge of smaller societies designed for their particular villages. Leaflets are being prepared, and these will be published when a favourable opportunity arises. The TROPICAL AGRICULTURIST contains regular articles on co-operation in English, and articles are contributed to the vernacular journals of the Agricultural Society GOVIKAM SANGARAWA and KAMAT TOLIL VELAKKAM, which have been distributed free of cost to all working societies as issued from the beginning of 1917. The Agricultural Society has also supplied seeds and plants to Co-operative Credit Societies and to their members on easy terms. The Colombo Commerical Company has continued to supply manures on easy credit terms to societies, and several of them have greatly benefited thereby.

27. The local press continues to take an interest in the matter of co-operation and is thereby helping the movement.

28. Thanks are due to the Registrars of the Co-operative Credit Societies in India for their publications, and for their ready replies to queries and for other information required for work in the Colony.

29. In conclusion, I may state that my short experience in the Colony has shown that these Co-operative Credit Societies are capable of much good work. Some societies are progressing satisfactorily, and there would appear to be no reason why greater numbers of societies should not also perform useful services. The improvement of the villager's agriculture, and with it his financial and moral condition, can be accomplished through these societies and it is hoped that when normal conditions prevail after the war, it may be possible to organize for a great expansion of the work. There are some Provinces in which Co-operative Credit Societies are few in number, and those few only working half-heartedly. These Provinces will require special attention, and societies may, under certain circumstances, require greater financial assistance from Government than what is being accorded at present. The Co-operative Credit movement has made wonderful progress in India, and is now being used for furthering schemes of colonization and agricultural development, and I am convinced that beneficial results would be obtained from similar efforts in this Colony.

30. The officers of the credit division of this Department have worked whole-heartedly towards the expansion of the movement, and especial mention should also be made of the many office bearers of the working societies that have given gratuitous help to the societies with which they are associated, in the effort to place them upon a sound working basis. Brief reports on the work of each society at present existing is appended hereto as an appendix. This record should prove a satisfaction to some of the office bearers of societies, while to others it is hoped that it will serve as a stimulus to better work in the future.

F. A. STOCKDALE,
Director of Agriculture,
Registrar of Co-operative Credit Societies.

June 25, 1917.

(To be continued.)

CATTLE INSURANCE IN BURMA.

The *Madras Bulletin of Co-operation* in its issue of June, 1917 (Vol. viii No. 4), publishes an interesting communication from MR. A. E. ENGLISH, Registrar of Co-operative Societies, Burma, on the above subject which deals with the establishment and the development of Cattle Insurance Societies in Burma.

"After some six years' experience in the introduction of co-operative credit into the various districts of Burma," says the writer, "it became clear that one of the chief causes of indebtedness was the loss of plough cattle by death from disease or accident." Having seen that the replacement of cattle thus lost by providing some form of insurance and by creating a spirit of corporate responsibility for tending of cattle are preferable to the mere granting of credit to replace such dead animals, efforts have been made to introduce a simple and suitable system of insurance of plough cattle suitable for Burma.

Before the scheme was launched following factors which are of vital importance to the successful working of the scheme were considered viz :— climates, crops, crop and season, cattle and system of cultivation and the tending of cattle of which there exist a variety in Burma. Owing to these considerations at first only draught cattle and those who were stall-fed were admitted for insurance as an experiment and also the area in which the societies to be started, restricted to 5 districts where conditions were considered favourable.

In the year 1911 the first six societies were registered. In 1911-12 there were 12 societies and in 1912-13 the number rose to 36.

In the year 1913 the whole subject was thoroughly discussed at the Agricultural and Co-operative Conference held at Mandalay and it was resolved at this meeting (a) to raise the premium from 3⅛ to 5 per cent. per annum of the value of the animal insured, (b) to cover deaths by rinderpest by insurance as it appeared that insurance would not become really popular unless the deaths from rinderpest were covered, (c) to restrict the membership of insurance societies to members of co-operative societies so as to eliminate the risk of fraud and (d) to establish a central Cattle Re-insurance Society with the sanction and financial support of the Government.

In the year 1915 sanction of the Secretary of State for India was obtained to a grant by way of an interest free loan, to the Central Re-insurance Society to enable it to meet indemnities in the early years. The amount to be drawn in any one year is not to exceed Rs. 25,000'00 and repayments are to be made from the sixth year onwards from the Reserve Fund of the Central Society.

The Central Society (Upper Burma Central Co-operative Cattle Re-insurance Society Limited) was registered in 1915. The membership consists of some 15 honorary members—persons interested in Cattle Insurance Societies. It receives half the premia paid to societies by members and insures half the risk undertaken by such societies. Indemnities due are paid

by the manager on receipt of a cattle death report giving full details. It is managed by a general meeting, committee and a manager. For the present the Registrar of Co-operative Societies is acting as honorary manager. To safeguard the interest of Government, a Government representative is a member of the general meeting and has five votes. The society has a general fund consisting of current year's premium income, and a Reserve Fund consisting of the net proceeds of past years. The affiliated societies submit to the manager of the Central Society half yearly statements showing the names of members and number, description and value of cattle insured.

By-laws of the village societies are based on those of the French Mutual Societies. The business is managed by a general meeting and a committee. There are usual exceptions of deaths from War, thefts, etc. The societies do not pay indemnities where the sanitary regulations as to contagious diseases have been broken. Membership is restricted. Valuations are made half-yearly by three experts appointed yearly by the general meeting. Substitution is permitted if values of the animals are equal. The premium rate is 5 per cent. per annum payable half yearly. Funds of the societies are deposited at the local credit society to be withdrawn at call. Deaths of animals have to be certified by the experts and the society only pays two-thirds of the value insured. The skin and flesh of the animal belong to the society. When saleable the society sells them. The owner gets two-thirds of the value of the animal insured whether his animal dies of a contagious or non-contagious disease. The number of societies registered in 1914-15 were only 7 and in the year 1915-16, 247 new societies were registered bringing the total to 305 at the end of June 1916. A considerable increase is expected in the coming year.

The number of members of these societies was 5045 and the number of cattle insured 7929 of the value of Rs. 287,051 and the amount of risk-re-insured is Rs. 113,050. The funds of the societies at the end of the year were Rs. 10,671 of which Rs. 9,737 were received by the societies as premia from members within the year ending June 1916.

75 insured animals died within the year and a sum of Rs. 689 paid to members as indemnities. Rs. 4022 were paid to the Central Society representing half of the premia received during the year. The cost of establishments of all the Societies was Rs. 219.

The Central Society insured half of the risk of affiliated societies' insurance and paid Rs. 247 as claims to affiliated societies. Its cost of management for the year was Rs. 148. At the end of the year ending 30th June this society had Rs. 2113 to the credit of the general fund and Rs. 1513 as Reserve Fund. The society has not drawn any money out of the Government loan. Judging by the steady accumulation of funds of these societies which have been working for several years and in view of the fact that only two-thirds of the value is paid in indemnity there is ground for believing that 5 per cent. rate of premium unnecessarily high It is also thought that the cattle are at present undervalued.

These societies are audited and supervised as is done in the case of Agricultural Credit Societies.

N. W.

CO-OPERATIVE SOCIETIES IN PUNJAB.

The Report of the Registrar of Co-operative Societies, Punjab, for the year ending 31st July, 1916, contains interesting and much valuable information apart from the usual information on facts and figures. The report records that the Societies flourished in spite of the effects of the War, and of the poor harvests on the financial situation of the Societies. In primary societies the deposits by members and others declined but these were more than made good by the loans of Central Banks. The Registrar says that the "inherent strength of the system sustained the strain well, for the year's profits yielded 8 lakhs while 5 lakhs of share capital was subscribed." The deficit was more than made good by large recoveries of overdue interest and the net result was an addition to working capital of primary societies of over 11 lakhs of rupees. The financial strain has made the members to realize their situation and has brought about the satisfactory results of replacing the money of outsiders by that of the members.

Punjab is far ahead of other Provinces in India in the matter of number of societies. At the end of the year under review there were 3,393 societies in all. Of which 3,319 were primary agricultural societies, 32 were non-agricultural and 42 Central societies.

123 agricultural, 2 non-agricultural and 2 central societies have been registered during the year.

The number of new societies would have been much more but the registrar's work during the year consisted of more of consolidation than of expansion of movement owing to insufficient staff at his disposal to cope with the work.

Membership. There seems to be a reduction in the number of members but this again is the result of consolidation as a number of nominal members who were allowed to pay a small fee at the early stages of the movement without taking a share were eliminated from the societies. Now all members must take at least one share. The number of members of all the societies at the end of the year was 148,043. Of these 141,666 were members of the primary agricultural societies, 2,969 of the non-agricultural and 3,408 were of central societies. The average number of members in each of a primary agricultural, non-agricultural and of central societies is 42, 92 and 81 respectively.

Capital. The working capital of all societies has been increased by the efforts of the members who increased their deposits while the outsiders withdrew the same due to financial crisis. The total working capital at the end of the year was Rs. 20,563,428'00 against Rs. 19,150,671'00 last year. The increase of the capital of primary agricultural societies was Rs. 1,160,792'00 and that of non-agricultural Rs. 19,742/- and of the central societies Rs. 232,223'00. The average working capital of each of the 3 types of societies is Rs. 4,465'00; Rs. 6,387'00, and Rs. 131,771'00 respectively. The average working capital per member of each of the 3 types of societies is also satisfactory as it works out at Rs. 106/- in a primary agricultural society, Rs. 69/- in a non-agricultural society and Rs. 1,626/- in a central society.

The Report as a whole is a very satisfactory one. The Registrar from his ripe experience touches on several questions which are of vital importance to the movement.

N. W.

POULTRY.

FEEDING BABY CHICKS.

JAMES HADLINGTON, *Poultry Expert.*

At the end of thirty-six or forty-eight hours is quite soon enough to feed the newly-hatched chicks, but water should be put before them immediately they are put into the brooder.

Nature has made provision for the sustenance of the newly-hatched chick by passing the yolk of the egg into the abdomen just previous to emergence from the shell. If chickens are fed too early the yolk may not become entirely absorbed, with the result that changes take place which frequently produce either diarrhoea or pasting up of the vent. It may, however, be mentioned that this is not the only cause of non-absorption of the yolk. Very often weakly chickens—whether the weakness is due to faulty incubation or to other causes—fail to properly absorb the yolk, and after hatching out apparently quite clean, they linger on, sometimes for a week or two, and eventually die. Post-mortem examination will show the cause of death to have been as stated. Hundreds of weakly chickens, which have no chance of living, are hatched in this way.

Many of the old time notions of feeding chicks with hard-boiled eggs, etc., are falling out of use, and simpler methods are being substituted. There is, perhaps, no better food for baby chickens for the first two days than rolled oats of an ordinary breakfast quality, to be followed by the class of food indicated later.

FEEDING CHICKENS.

If not complicated by the many fads and theories that are current, feeding chickens successfully is a simple matter. Unfortunately the beginner, and some whose experience should deter them from following anything but what has been well proved in practice, are somewhat prone to be swayed by unsound advice and doubtful experiments. They would be well advised, however, to follow methods that are giving satisfactory results, and if an experiment is to be tried to confine it to small dimensions, so that the whole of the flock will not be jeopardised.

A great deal more depends upon sound methods of feeding than is generally realised. We must not only feed to keep chickens alive and to prevent gastric troubles (upon which so much stress is sometimes laid), but we must feed with the object of obtaining the best possible development. This is a phase of feeding that very often does not receive sufficient consideration. Good steady growth from the shell to maturity, and an absence of checks not only ensures the most economical use of the food, but also tends to develop a much larger and stronger bird. Neither the chemical value of foodstuffs, nor even the digestible constituents taken alone, is a safe basis upon which to build a ration. Other considerations enter into the calculation, such as variety and palatability. Any ration, however well balanced, that ignores these vital factors will fail to produce satisfactory results.

It will therefore be seen how complicated the feed problem becomes when beaten tracks and practical experience are departed from. Once these facts are realised, the wise poultryman will tread the paths of experimentation warily. In regard to scientific feeding in general, even food chemists are not slow to emphasize the fact that the only reliable guides to the true value of a ration are the results obtained from it. Then, again, foods, even though they contain the same elements, may be appetising or otherwise, according to the

manner in which they are fed ; the practice of feeding dry mash to chickens is a case in point. Dry mash is certainly not as appetising as a properly mixed semi-wet mash ; this can be verified by noting how chickens will leave dry mash and greedily eat up wet mash—provided it is not too wet.

DRY MASH UNSUITABLE FOR CHICKENS.

Whatever advantage there may be in feeding dry mash to adult fowls, I am convinced after careful observation that attempts to raise chickens on it are fraught with very grave consequences to the poultry industry. The results arising from the method are so insidious that it sometimes takes years to convince its devotees of its failure to produce satisfactory results. A small loss in development from one year to another is often not recognised until irreparable damage has been done to the flock ; but some poultry farmers are fortunately finding this out. Dry feeding as a system is similar to intensive methods in its effects, producing a falling off in size and stamina. At the same time dry mash feeding should not be confused with the feeding of dry grains or of chicken mixtures ; the last is far preferable to dry mash, and, of course, can be fed in hoppers in the same way. Experience teaches that to get chickens to eat the maximum amount of food we must supply at least a portion of that food in a palatable and easily digested form, and perhaps the nearest we can get to that is a semi-wet mash.

A PROVED METHOD.

The feeding method at Hawkesbury Agricultural College, and on many big commercial farms in this State, is to give at least two-thirds of the whole of the ration for chickens until they are, say, 6 or 8 weeks old, in the form of semi-wet mash mixed with milk, the balance being chicken mixture, mostly fed towards evening. The method of mixing this semi-wet mash is to scald the proportion of bran (generally about one-third) with hot milk ; this portion will then be like a bran mash. Sufficient pollard is then added to work it up into a crumbly consistency, and the mash is then fed in troughs. Mixing twice per day is quite sufficient to ensure its being in a sweet, wholesome condition. Enough can be mixed for hundreds of chickens in about ten minutes, so that the saving of labour in the use of dry mash for chickens is not so great a consideration as might appear. There is, of course, the little time taken up in actually giving the food round, but what successful operator in rearing chickens would not require to visit and regulate matters in connection with his charges more times a day than this method involves ?

In a business so full of detail as that of poultry-raising it is laudable to aim at saving every minute, and to cut out every useless movement ; but it will not pay to sacrifice anything in the development of the stock for so small a consideration, because upon development depends the success of the business.

GENERAL CONSIDERATIONS.

Careful and systematic feeding is also necessary to obtain the best results. Chickens should not only be well fed, but they should be induced by considerations of palatability to take the largest amount of food, in order that there may be developed, as a constitutional character, a capacity for the consumption and assimilation of large quantities of food. This is quite essential to the maintenance of a high standard of egg-production when adult age is reached.

Chickens should never be allowed to go too long without food, nor should they become surfeited with it.

After leaving the brooders, the number of times a day at which chickens are fed should be gradually reduced, say, to four times at 10 weeks old, afterwards to three times daily, and later on to simple adult feeding. The observant poultry keeper will soon find from experience how many times per day feeding is necessary, for he will learn from the chickens themselves.—

AGRIC. GAZ. of N.S.W., Aug., 1917.

GENERAL.

A PRELIMINARY NOTE ON A RECENT EXPERIMENT ON THE PRUNING OF TEA SEED-TREES.

In the cold weather 1915-16 some experiments were commenced on the pruning of seed tea on the Rangajan T.E. Jorhat Tea Co. There are some acres of old trees and some newly planted. The old trees were quite healthy and yielding fairly well but they had grown much too tall, having long barren stems bearing all the fresh growth on their tops. Most of the plants had a number of branches which had become very congested in the centres. It was therefore decided to remove the centres from all the plants. An acre was then pruned 6 or 7 feet from the ground. The branches on some of the trees were then spread out by inserting bamboos between them. In the rainy season 1916 the succulent shoots which were growing too high were pinched back and some attempt made to keep the branches from becoming too congested by nipping out superfluous ones at the same time. The pruned trees have flowered this season and the seed is undoubtedly better in quality and quantity than that from unpruned plants. It is too early to say whether 6 or 7 feet is the best height to prune. The writer is inclined to think that 3 or 4 feet would be better although it would lead to the production of more vegetative growth and it may be necessary to wait longer for the trees to produce seed again. The spreading of the branches by bamboos was a failure: the bamboo spreaders damaged the bark and did very little good. The shape of the trees can only be satisfactorily made by judicious pruning. The pinching back of the succulent shoots is very important as by that means the shape of the tree can be formed with the least stock. It is very important however, that it be done in the late rains. If it is done too early, the plant begins to flush, if too late, too much succulent growth is produced in the early part of the next season.

The young tea was treated in various ways including pruning at different heights and the spreading out of branches by bamboo frames. It seems, however, that the only satisfactory way is to let the young plants grow up until their stems are fairly thick (say one inch in diameter) and then prune to a few inches above the ground. If as soon as the shoots are hard enough to stand bending a good sized brick is fixed in the centre of the young bush the stems will not be able to grow up close together and a satisfactorily shaped tree is obtained without further heavy pruning. The shoots should be pinched back in the late rains and only those required to produce seed retained.

This note is only a preliminary one and further details will be published when the experiment is more advanced.—A. C. T. IN THE QUARTERLY JOURNAL OF THE INDIAN TEA ASSOCIATION, Pt. ii, 1917.

RAINWATER AND OXYGEN.

That showers of rain benefit the growing crop is well-known to agriculturists. Is this to be considered as only a moisture affect or something more? LIEBIG thought that rain brought down sufficient quantities of ammonia to influence the growth of a crop. This has been disproved by analyses. We may assume that in the ordinary course of events the land receives about 4 or 5 lb. of combined nitrogen per acre per annum, a very insignificant amount when compared with a plant's requirements.

Recently RUSSELL and APPLEYARD on studying the decomposition of organic matter in soil (JOURN. AGR. SCI. VOL iii. PT. 3., P. 385) show how first temperature and then rainfall become important factors in determining the biochemical decompositions in the soil. Below 5°C there is no notable action in the soil, as the temperature rises the biochemical decompositions mainly brought about by bacteria begin rapidly but this action soon slows down as other factors begin to operate. Moisture is one of these. The moisture curve, however, does not fit very well with the curves of biochemcial activity. The rainfall curve fits better. In fact, rainfall becomes the dominant factor. A shower of rain is sufficient to begin the decompositions. Something more than moisture is apparently required. RICHARDS shows in another paper (ibid p. 331) that rain is merely a saturated solution of oxygen. It is suggested, therefore, that the dissolved oxygen of the rain is the important factor. RICHARDS shows, however, that when the temperature of rain is above 15°C. the dissolved oxygen is always below saturation and may be by as much as 25%.

These results make one to inquire in what state is oxygen taken in by roots of a plant. In the gaseous state or in the dissolved state? There is a large amount of evidence to favour the latter view. HARRISON's investigations into the gases of swamp rice soils show how the organised surface film "may be looked upon as fulfilling the duty of an oxygen concentrator at a point which enables the maximum oxygen concentration to be produced in the water entering the soil." HOLE's investigations on seedlings of *Sal (Shora robusta)* show that soil-aeration is the factor limiting development. "At the same time, cases are known where *Sal* is growing well with its roots in practically saturated soil, if not indeed entirely in water, on the banks of streams or even of lakes of more or less stagnant water. Stagnant water in which algæ and other green plants are growing, however, may be actually richer in oxygen than the atmosphere itself and the question is obviously not so much one of the relative quantity of water as of the gases and other substances which are in solution in the water." That water can actually be richer in oxygen than air is not readily realized. That rainwater supplies oxygen as well as water to plants and to soil-bacteria may make it necessary for us to carefully revise our ideas of the nutrition of plants.

H. L. VAN B.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st OCTOBER, 1917.

Province.	Disease	No. of cases to date since Jan. 1st 1917.	Balance remaining end of preceding week.	Fresh cases during the month	Recoveries.	Deaths.	Balance ill.	No. shot.
Western	Rinderpest	314	3	234	40	248	7	19
	Foot & mouth disease	684	3	5	680	2	2	—
Colombo Municipality	Rinderpest	792	—	104	—	—	—	—
	Anthrax	5	—	—	—	—	—	—
	Foot & mouth disease	344	—	—	—	—	—	—
	Rabies	47	—	1	—	47	—	—
Quarantine Station	Anthrax	122	—	1	—	—	—	—
	Foot & mouth disease	10	—	—	—	—	—	—
Central	Rinderpest	85	—	2	27	52	—	6
	Anthrax	33	—	2	—	26	—	7
	Foot & mouth disease	393	12	77	345	—	48	—
Northern	Foot & mouth disease	132	—	—	131	1	—	—
	Anthrax	22	—	—	—	22	—	—
North-Western	Rinderpest	190	—	129	54	113	19	4
	Foot & mouth disease	1186	—	12	1184	1	—	1
	Rabies	1	—	—	—	1	—	—
Eastern	Foot & mouth disease	942	15	49	894	19	21	8
Sabaragamuwa	Rabies	1	—	—	—	1	—	—
	Rinderpest	46	—	13	6	32	1	7
	Foot & mouth disease	521	—	—	521	—	—	—
Uva	Rinderpest	28	—	5	6	16	—	6
	Foot & mouth disease	916	19	32	874	26	16	—
North-Central	Foot & mouth disease	929	258	21	666	5	258	—
Southern	Foot & mouth disease	37	—	—	37	—	—	—
	Rabies	2	—	—	—	2	—	—

G. W. STURGESS, G.V.S.

METEOROLOGICAL.

OCTOBER, 1917.

Station.	Temperature: Mean Daily Shade	Temperature: Difference from average	Mean Humidity	Mean amount of cloud 0=clear, 10=Overcast	Mean Wind direction during month	Daily mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy days	Rainfall: Difference from average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	79·8	-0·4	81	6·4	WSW	122	4·24	16	-10·04
Puttalam	80·7	-0	79	5·0	SW	213	1·21	6	-7·90
Mannar	81·9	-0·5	74	6·7	SW	155	4·82	5	-3·21
Jaffna	81·6	+ 0·1	78	3·4	SW	259	2·61	6	-6·78
Trinco'mee	82·8	+ 0·5	68	5·6	WSW	213	1·70	5	-6·48
Batticaloa	81·9	+ 0·2	70	4·8	Variable	73	0·81	4	-5·71
Hambantota	80·6	+ 0·2	77	4·7	WSW	328	1·11	10	-3·75
Galle	78·7	-0·9	84	7·0	WNW	256	7·33	13	-6·31
Ratnapura	78·7	-1·3	78	6·1	—	—	13·58	15	-5·76
Anu'pura	80·0	-1·4	76	6·6	—	—	11·66	9	+2·14
Kurunegala	79·4	-1·0	74	6·8	—	—	10·45	14	-5·13
Kandy	74·5	-1·3	75	6·8	—	—	9·07	18	-2·84
Badulla	72·0	-2·3	74	5·8	—	—	5·06	13	-4·43
Diyatalawa	68·8	+ 0·4	62	5·6	—	—	3·77	10	-6·45
Hakgala	60·2	-0·8	76	6·8	—	—	9·24	17	-2·91
N'Eliya	59·8	+ 0·4	74	7·0	—	—	6·37	15	-4·74

Owing to disturbed weather conditions rain was practically general from the 13th to the 20th. For the remainder of the month it was fine, except for occasional showers up-country and to the South-west

But for a few centrally situated stations where a slight excess was recorded the rainfall was mostly in marked deficit, as was the number of days on which rain fell.

To the East the mean shade temperature was a trifle above that of the normal and below elsewhere.

The wind velocity was greater than usually experienced in October.

J. E. EVANS,
Acting Supdt., Observatory.

MARKET RATES FOR TROPICAL PRODUCTS.

(From Lewis & Peat's Latest Monthly Prices Current.)

	QUALITY.	Quotations.
ALOES, Soccotrine cwt.	Fair to fine	93/ a 100/
Zanzibar & Hepatic ,,	Common to good	40/ a 100/
ARROWROOT (Natal) lb.	Fair to fine	7d a 7½d
BEES' WAX cwt.		
Zanzibar Yellow ,,	Slightly drossy to good	£9 10/ a £9 15/
East Indian bleached ,,	Fair to good	£10 17/6a £11 5/
,, unbleached ,,	Dark to good genuine	£9 a £9 15/
Madagascar ,,	Dark to good palish	£9 5/ a £9 15/
CAMPHOR, Japan lb.	Refined	3/ a 4/
China cwt.	Fair average quality	180/ nom.
CARDAMOMS, Tuticorin	Good to fine bold	3/6 a 4/6 nom.
per lb.	Middling lean	2/ a 2/9 ,,
Malabar, Tellicherry ,,	Good to fine bold	3/ a 4/ ,,
Calicut ,,	Brownish	1/9 a 2/6 ,,
Mangalore ,,	Med Brown to good bold	2/6 a 5/3 ,,
Ceylon, Mysore ,,	Small fair to fine plump	2/ a 5/
Malabar ,,	Fair to good	1/7 a 1/8
Seeds, E. I. & Ceylon ,,	Fair to good	1/9 a 2/
Ceylon "Long Wild" ,,	Shelly to good	1/ a 1/6 nom.
CHILLIES, Zanzibar cwt.	Dull to fine bright	70/ a 75/
Japan ,,	Fair bright small	60/ a 70/
CINCHONA BARK.—lb.	Crown, Renewed	3⅜d a 7d
Ceylon	Org. Stem	2d a 6d
	Red Org. Stem	1¾d a 4¼d
	Renewed	3d a 5¼d
	Root	1⅞d a 4d
CINNAMON, Ceylon 1sts.	Fair to stout quill	2/6
per lb. 2nds.	,, ,,	2/3
3rds.	,, ,,	2/
4ths.	,, ,,	11d
Chips.	Fair to fine bold	10½d
CLOVES, Penang lb.	Dull to fine bright pkd.	2/6 a 2/9
Amboyna ,,	Dull to fine	1/10 a 2/
Zanzibar ,,	Fair and fine bright	1/10 a 2/
Madagascar ,,	Fair	1/10 a 2/
Stems ,,	Fair	7d
COFFEE		
Ceylon Plantation cwt.	Medium to bold	Nominal
Liberian ,,	Fair to bold	,,
CACAO, Ceylon Plant. ,,	Special Marks	79/ a 82/
	Red to good	70/ a 78/
Native Estate ,,	Ordinary to red	50/ a 74/
Java ,,	Small to good red	70/ a 96/
COLOMBO ROOT ,,	Middling to good	85/ a 100/
CROTON SEEDS, sifted ,,	Dull to fair	70/ a 75/
CUBEBS ,,	Ord. stalky to good	£16/ a £18/
FIBRE, Kitul lb.	OOO good long	10d a 11d
	OO ,, medium	8½d
	No. 1 fair	7d
Palmyrah ton.	Common to fair	£30/ a £35 nom.
,,	Medium to good med	£40/ a £45 ,,
	Good to fine	£50/ a £60 ,,
GINGER, Bengal, rough cwt.	Fair	62/6
Calicut, Cut A ,,	Medium to fine bold	95/ a 100/
B & C ,,	Small and medium	85/ a 90
Cochin, Rough ,,	Common to fine bold	67/6 a 72/6
	Small and D's	67/6
Japan ,,	Unsplit	45/
GUM Ammoniacum ,,	Ord. blocky to fair clean	60/s a 85s nom.
Animi, Zanzibar	Pale and amber, str. srts	£14 10/a £16 10/
,,	,, ,, little red	£11 a £12
,,	Bean and Pea size ditto	70/ a £11
,,	Fair to good red sorts	£8 10/ a £10 10/
,,	Med. and bold glassy sorts	£5 10/ a £7 5/
Madagascar ,,	Fair to good palish	£4 a £8
,,	,, ,, red	£4 a £7
Arabic, E. I. & Aden ,,	Ordinary to good pale	55/ a 75/
Turkey sorts ,,	... ...	80/ a 82/6
Ghatti ,,	Sorts to fine pale	30/ a 50/
Kurrachee ,,	Reddish to good pale	35/ a 50/ nom.
Madras ,,	Dark to fine pale	30/ a 45/ nom.
Assafœtida ,,	Clean fr. to gd. almonds	£15 a £20
	com. stony to good block	£4 a £10
INDIGO, E.I. Bengal lb.	Shipping mid to gd. violet	11/6 a 13/
,,	Consuming mid. to gd.	10 6 a 11/6
,,	Ordinary to middling	9 6 a 10/6
,,	Mid. to fine Kurpah	8/ a 9 6
,,	Low to ordinary	6/ a 7/6
,,	Mid. to fine Madras	2/6 a 4/6
KAPOK-Ceylon lb.	Ordinary to good	1/ a 1/4
KINO lb.	Fair to fine bright	6d a 1/5
MYRRH, Aden sorts cwt.	Middling to good	160/ a 190/
Somali ,,	,, ,,	130/ a 150/
MACE, Bombay & Penang		
per lb.	Pale reddish to fine	2/4 a 2/9
	Ordinary to fair	2/2 a 2/4
Java	,, ,, good pale	2 4 a 2/9
Bombay	Wild	6d

	QUALITY.	Quotations.
NUTMEGS,— lb.		
Singapore & Penang ,,	64's to 57's	1/9 a 2/
	80's	1/6
	110's	1/2
NUX VOMICA, Cochin	Ordinary to good	35/ a 40/
per cwt. Bengal	,, ,,	30/ a 32/6
Madras	,, ,,	30/ a 35/
OIL OF ANISEED lb.	Fair merchantable	4/6
CASSIA ,,	According to analysis	5/6 a 5/9
LEMONGRASS oz.	Good flavour & colour	4¾d
NUTMEG ,,	Dingy to white	1½d a 1¾d
CINNAMON (Ceylon)	Ordinary to fair sweet	6d a 2s
CITRONELLE ,, lb.	Bright & good flavour	2/2
OLIBANUM, drop cwt	Good to fine white	130/ a 150/
,,	Middling to fair	100/ a 120/
pickings ,,	Low to good pale	22/6 a 40/
siftings ,,	Slightly foul to fine	35/ a 45/
ORCHELLA WEED—cwt		
Ceylon ,,	Fair	10/6
Madagascar ,,	Fair	10/6
Zanzibar ,,	Fair	10/6
PEPPER—(Black) lb.		
Alleppy & Tellicherry	Fair	1/3
Ceylon ,, ,,	Fair to fine bold heavy	11d a 11¼d
Singapore ...	Fair	1/1½d
Acheen & W. C. Penang	Dull to fine	1/2
(White) Singapore ,,	Fair to fine	1/5
Siam ,,	Fair	1/5
Penang ,,	Fair	none
Muntok ,,	Fair	1/5½
RHUBARB, Shenzi ,,	Ordinary to good	1/4 a 3/
Canton ,,	Ordinary to good	1/3 a 2/6
High Dried ,,	Fair to fine flat	1/7 a 1/9
RUBBER, INDIA lb.	Standard smoked sheets	2/7
Ceylon, Straits, ,,	Standard Crepe	2/9
Malay Straits, etc. ,,	Scrap fair to fine	1/8
Assam ,,	Fair 11 to ord. red No. 1.	1/4
Rangoon ,,	,, ,, ,,	1/6
Borneo ,,	Common to good	1/6
Java ,,	Good to fine red	1/8 a 2/
Penang ,,	Low white to prime red	1/6 a 1/9
Mozambique ,,	Sausage, fair to good	1/6 a 2/
Nyassaland ,,	Fair to fine ball	1/6 a 2/
Madagascar ,,	Fr. to fine pinky & white	1/4 a 1/7
,,	Majunga & blk coated	1/
,,	Niggers, low to good	9d a 1/6
New Guinea ,,	Ordinary to fine ball	1/6 a 2/
SAGO, PEARL, large—cwt	Fair to fine	50/ a 55/
medium ...	,, ,,	50/ a 55/
small ...	,, ,,	50/ a 55/
Flour ...	Good pinky to white	40 a 42/6
SEEDLAC cwt.	Ordinary to gd. soluble	175/ a 200/ nom.
SENNA, Tinnevelly lb.	Good to fine bold green	10d a 11d
	Fair greenish	6½d a 9d
	Common specky & small	3½d a 5½d
SHELLS, M. of PEARL—		
Egyptian cwt.	Small to bold	40/ a £5 10/ nom
Bombay ,,	,, ,,	55/ a £5 15/ ,,
Mergui ,,	Chicken to bold	£6 15/ a £10/ ,,
Manilla ,,	,, ,,	£6 a £10/ ,,
Banda ,,	Sorts	40/ a 45/ ,,
Green Snail ,,	Small to large	50/ a 75/ ,,
TAMARINDS, Calcutta...	Mid to fine bl'k not stony	40/ a 45/
per cwt. Madras	Inferior to good	25/ a 30/
TORTOISE SHELL—		
Zanzibar & Bombay lb.	Small to bold	10/ a 25/
	Pickings	5/ a 15/
Ceylon	Small to bold	10/ a 22/
Mauritius & Seychelles	,, ,,	10/ a 25/
TURMERIC, Bengal cwt.	Fair	47/6
Madras ,,	Finger fair to fine bold	50/ a 52 6
Do. ,,	Bulbs ,, ,, [bright	42/6 nom.
Cochin ,,	Finger fair	45/ nom.
	Bulbs ,,	37/6
VANILLA.— lb.		
Mauritius ... } 1sts.	Gd. crystallized 3½a 8½ in.	5/6 a 9 6
Madagascar ... } 2nds.	Foxy & reddish 3½a ,,	5/ a 7/
Seychelles ... } 3rds	Lean and inferior	5/ a 5/9
WAX, Japan, squares, cwt.	Good white hard	80/